

## Activity 5.4: Other Organic Materials Reading Propane, and Propane Combustion

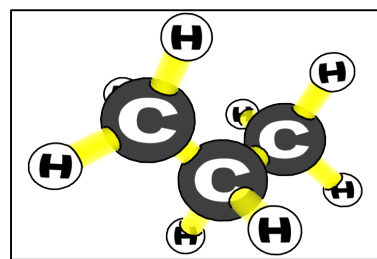
If you have ever seen a gas grill or a large steel tank outside of your home you probably have heard of propane, but what is it? You can't see through the steel tank, so you cannot see what it looks like.

The energy that makes propane starts out as chemical energy in the molecule of propane. This reading answers two questions:

1. What is propane?
2. How does a propane grill work?

### **What is propane?**

Propane is an organic molecule that has the chemical structure:  $C_3H_8$ . It is a hydrocarbon: a molecule made up of only carbon and hydrogen. Here is a diagram of the structure of a single propane molecule. Propane is a colorless gas at normal atmospheric pressure, but when it is compressed it condenses and becomes a liquid.



Since it has all C-C and C-H bonds, propane is a good fuel: It releases a lot of energy when it is burned. Propane is also a *fossil fuel*: It was formed by the decay of plants and animals millions of years ago, and now we can pump it up from underground as one component of petroleum and natural gas—both mixtures of hydrocarbons and other molecules. The petroleum and natural gas are sent to refineries—processing plants that separate them into different kinds of molecules, including propane.

Since propane is a colorless gas, it's hard to see. But it's easy to see tanks full of propane that we use for fuel like those below. Gas grills use small propane tanks. Some houses or businesses have large propane containers that provide fuel for heating and cooking. These containers hold propane under pressure. This pressure on the gas turns it into a liquid for storage.



["A 20 lb \(9.1 kg\) steel propane cylinder"](#) by [Hustvedt](#) is licensed under [CC BY 3.0](#)



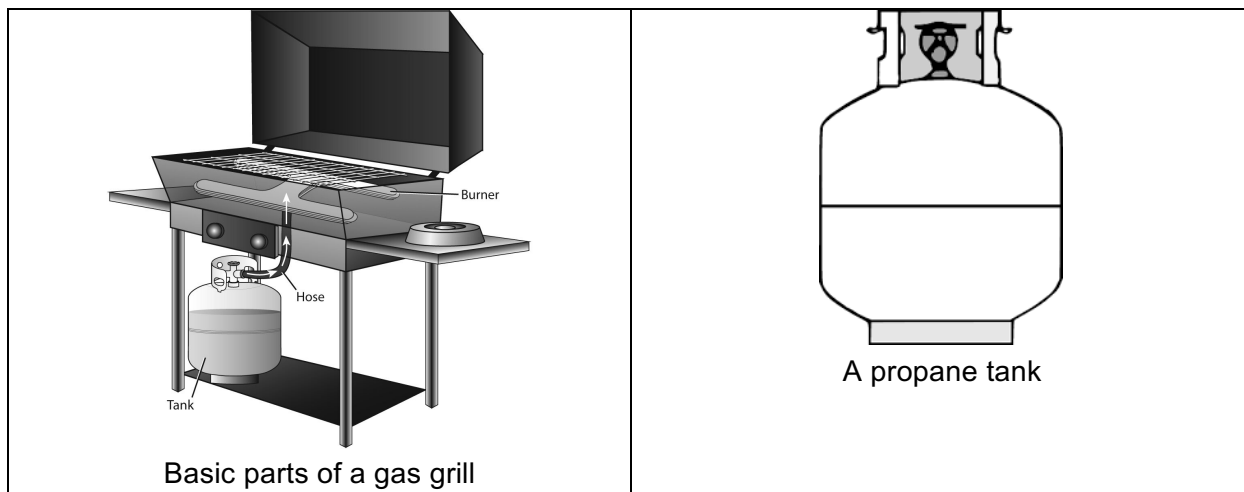
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## How does a propane grill work?

One of the most common uses of propane is for cooking foods on gas grills. Gas grills turn the chemical energy in propane into heat for cooking. Let's start by looking at the structure and function of a gas grill.

Gas grills have lots of parts. The diagram below shows just the most important ones. The grill has:

- A propane tank
- Hoses that carry propane gas to the burners
- Burner tubes that mix propane with air, then release it to be burned



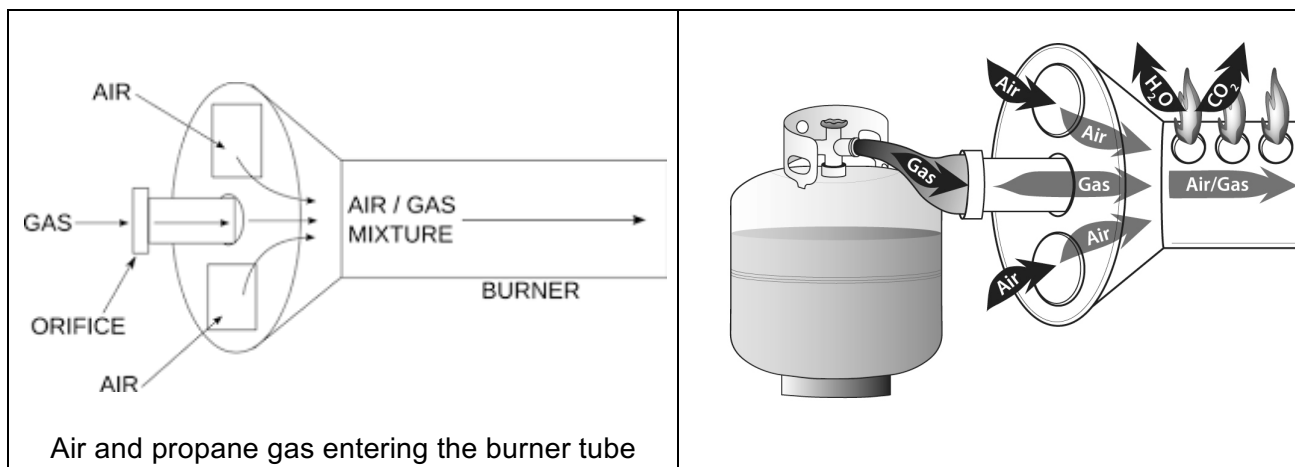
The arrows show how propane gets to the burners. So, here's a puzzle. If the propane liquid is in the *bottom* of the tank, why is the valve that releases propane at the *top* of the tank? Putting the valve at the top of the tank is actually a clever design.

- Propane gas goes into the hose from the valve.
- When propane gas leaves the tank, then some of the propane liquid evaporates.
- So as long as there is any liquid to evaporate, the tank stays full of propane gas under pressure.

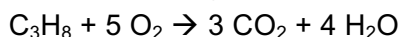
Now let's look more closely at what happens when propane reaches the burner tubes. We can tell the story of what happens next by answering the Three Questions, using the same four steps as you used to explain burning ethanol.

**Step 1. Matter movement.** Here's another puzzle: Why is the flame from a propane burner blue rather than yellow?

The answer to this question is that propane can burn hotter and cleaner if it is mixed with air *before* it starts to burn, so propane burners do that. The diagram on the left below shows how that happens. Then the propane and air mixture leaves holes in the burner tube. The spark that starts them burning is outside the tube. The diagram on the right below show what happens next.



**Step 2. Matter change.** When propane is mixed with oxygen, a spark can start a combustion reaction. This combustion reaction rearranges the atoms in the oxygen and propane to form carbon dioxide and water. (If there is not enough oxygen mixed with the propane then it will not be able to completely react and will form a poisonous gas: carbon monoxide or CO). Here's the chemical equation for propane burning:



**Step 3. Energy change.** When propane burns, the chemical energy in its C-C and C-H bonds is released—a lot of heat! This energy is what heats up the air around the flame.

**Step 4. Matter movement.** The products of water and carbon dioxide leave the flame and spread out into the air.

### ***Digging deeper***

Here are some more places that you can go to learn about where propane comes from, what is in it, and how combustion works:

- Read more about where propane comes from and what it is:
  - University of Colorado Article, <http://lsa.colorado.edu/essence/texts/propane.html>
- Learn more about how propane tanks work:
  - How propane tanks work: <https://www.youtube.com/watch?v=CDFoAaVZITU>
- Learn more about where propane comes from and how scientists are working on figuring out renewable ways to make propane:
  - Renewable ways to form propane: <https://www.theguardian.com/environment/2014/sep/02/propane-renewable-sources-ecoli-genes>