

## Applied Stoichiometry: The Chemistry of Flatulence

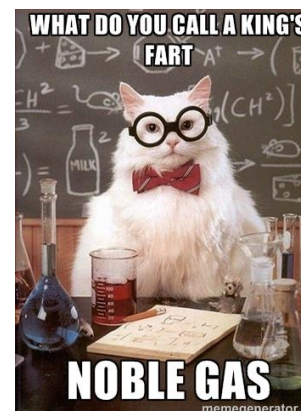
Methane,  $\text{CH}_4$ , is the main component of natural gas. Natural gas is a popular fuel for generating electricity in power plants and heating homes. If you have a gas stove, it may operate on methane or propane. Methane is a cleaner fuel than many other hydrocarbons because it produces less carbon dioxide per unit of heat or thermal energy as it combusts. In its liquid form, it is used as rocket fuel.

Methane is also produced in the human gut during digestion. As it passes through the digestive tract, it collects at the lower end and is emitted as flatulence or a fart. The hydrogen and methane in flatulence are of course, flammable. About 10% of a fart is composed of methane. The other gases include hydrogen, nitrogen, oxygen, and carbon dioxide. Most of the gas emitted by humans in this way is nitrogen and carbon dioxide that was ingested in swallowing food and drinks.

If a fart is smelly, it isn't the methane. It's the presence of hydrogen sulfide, a gas with the distinct odor of rotten eggs. The chemical composition and thus odor of farts differs according to your health and diet, so you would expect a vegetarian's farts to smell different from those produced by a person who eats meat. Hydrogen sulfide is added to natural gas used in homes for heat and fuel so that we can smell a leak as it occurs.

The average human fart contains .00643 g of methane gas.

- 1) Write and balance the reaction for the combustion of methane:
  
  
  
  
  
  
  
  
  
  
- 2) If you were to light said fart (and you SHOULD NOT. It is seriously dangerous.), what mass of oxygen would combust along with it?
  
  
  
  
  
  
  
  
  
  
- 3) People pass, on average, .75 LITERS of gas per day. This is about .0536 g of methane per 24 hour period because only 10% of it is methane. What mass of water could be generated by ignition of these methane emissions for one person?
  
  
  
  
  
  
  
  
  
  
- 4) How many water molecules is this?



But the problem is bigger than this. Cows and other ruminant animals like sheep and goats are primary sources of dairy and meat in the U.S. and they have so much trouble digesting grass that they have additional stomachs to aid in processing it.

A 1995 study of methane emissions from cattle found that cows typically lose about 6 percent of their ingested energy as methane, partly a result of their slow digestive process. A single cow can produce between 250 and 500 liters, or about 66 to 132 gallons, of methane a day (the average U.S. vehicle gas tank can hold about 16 gallons of gas).

- 5) What mass of methane does a single cow produce? Calculate the high and the low end, please.
  
  
  
  
  
  
  
  
  
  
- 6) There are approximately 39,000,000 beef and dairy cattle in the US. What mass of methane is this per year?

Finally, on January 28, 2014, in Germany, a barn containing 90 cows exploded when a stray spark caught the methane trapped in the building on fire. The building was damaged and one cow was slightly injured with minor burns. Assume that the 90 cows were producing 250 L of methane per day and that there was a 15 hour collection in the barn when it ignited. What mass of water was generated in the explosion?

