Fuels: What is a fuel?

"Any material that can be burned to release thermal energy is called a ***fuel."*** *.*

Hydrocarbon Fuels

Combustion Reaction:

$$\text{Fuel} + x\,O_{2(g)} \rightarrow y\,CO_{2(g)} + z\,H_2O_{(g)}$$

Breaking C-H & C-C Bonds

Breaking O=O Bonds

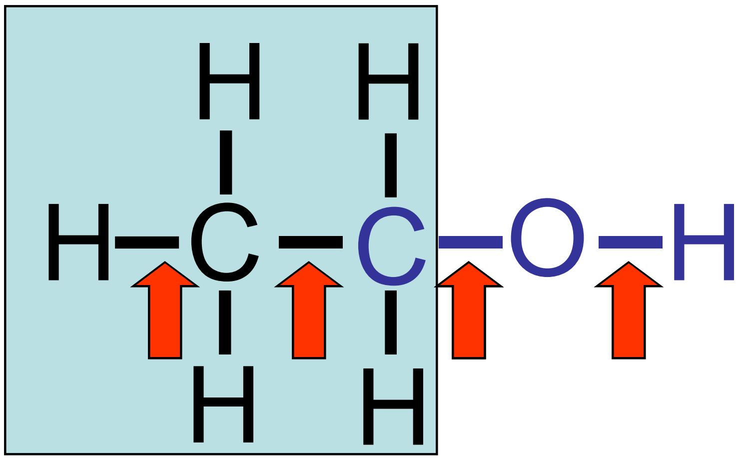
Making C=O Bonds

Making O-H Bonds

Question: ***How should the "bonds made energy" compare to the "bonds broken energy" for an energy rich fuel?***

Answer: ***The hydrocarbon bond energies (C-H and C-C) should be lower energy in comparison to the bonds made (C=O and O-H).***

Factors Affecting Fuel's Energy



Ethanol

$\Delta H_{combustion}$ **= -1368 kJ/mol**

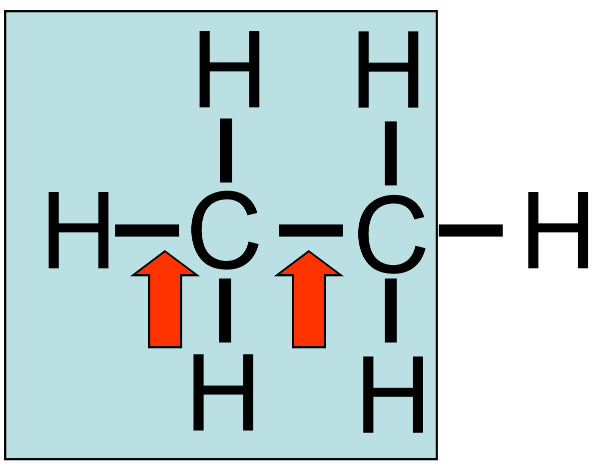
...less energy rich fuel

Bonds to break:

C - H	C - C	C - O	O - H
413 kJ/mol	*347 kJ/mol*	*358 kJ/mol*	*464 kJ/mol*

Relatively higher energy bonds must be broken!

...Reduces available combustion energy.



Ethane

$\Delta H_{combustion}$ **= -1560 kJ/mol**

...More energy rich fuel.

Bonds to break:

C - H	C - C
413 kJ/mol	*347 kJ/mol*

Fuel Comparisons: Heats of Combustion

		$\Delta H_{combustion}$
Hydrogen		
$H_{2(l)}$	$+ \frac{1}{2} O_{2(g)} \rightarrow H_2O_{(l)}$	**-284 kJ/mol**
Methane		
$CH_{4(g)}$	$+ 2\ O_{2(g)} \rightarrow CO_{2\ (g)} + 2H_2O_{(l)}$	**-891 kJ/mol**
Ethanol		
$C_2H_5OH_{(l)}$	$+ 3\ O_{2(g)} \rightarrow 2CO_{2\ (g)} + 3H_2O_{(l)}$	**-1368 kJ/mol**
Gasoline		
$C_8H_{18(l)}$	$+ 12 \frac{1}{2} O_{2(g)} \rightarrow 8CO_{2\ (g)} + 9H_2O_{(l)}$	**-5452 kJ/mol**

Per mole, the combustion of gas produces a lot of Energy!

http://www.chem.ox.ac.uk/vrchemistry/energy/

Fuel Comparisons: Heats of Combustion

	$\Delta H_{combustion}$	$\Delta H_{combustion}$	$\Delta H_{combustion}$
Hydrogen $H_{2(l)}$	-284 kJ/mol	-142 MJ/kg	-8 MJ/L
Methane $CH_{4(g)}$	-891 kJ/mol	-56 MJ/kg	-10 MJ/L
Ethanol $C_2H_5OH_{(l)}$	-1368 kJ/mol	-30 MJ/kg	-19.59 MJ/L
Gasoline $C_8H_{18(l)}$	-5452 kJ/mol	-48 MJ/kg	-29.0 MJ/L

Per gram, hydrogen is a very energy rich fuel!

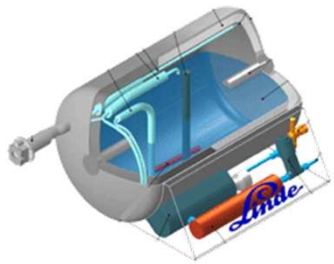
Per Liter, gasoline is a very energy rich fuel!

http://www.chem.ox.ac.uk/vrchemistry/energy/

Fuel Comparisons: Storage

Hydrogen

$H_{2(l)}$



Liquid Hydrogen Cryostat

http://www.hydrogen-cars.biz/liquid-hydrogen.htm

Liquid hydrogen must be stored in an insulated container to reduce boil off losses.

Methane

$CH_{4(l)}$

Methane must be stored at high pressures in metal containers to keep it a liquid.

Ethanol

$C_2H_5OH_{(l)}$

Existing infrastructure can be used to transport and delivering gasoline!

Gasoline

$C_8H_{18(l)}$

Infrastructure exists for transporting and delivering gasoline!

A future with no Fossil Fuel?

Fossil fuel production is expected to peak in the next 10 – 30 years.
(estimates vary a lot)

http://edugreen.teri.res.in

...at which point fossil fuel reserves will begin to decrease

Hybrid technologies, new battery technologies and alternate fuels will be employed to keep automobiles on the road.

...but a question....

What will we use as an airplane fuel in the future when no fossil fuels are left?

Leave your response on the D2L bulletin board.