Re: H2 burner

Source: http://sci.tech−archive.net/Archive/sci.energy.hydrogen/2008−06/msg00015.html

- *From*: Williamknowsbest <William.Mook@xxxxxxxxx>
- *Date*: Fri, 6 Jun 2008 20:53:48 −0700 (PDT)

On Jun 6, 10:20 pm, Eeyore <rabbitsfriendsandrelati...@xxxxxxxxxxx>
wrote:

> Williamknowsbest wrote:
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>> Harry
>>
>> While we agree on the importance of marginal value we disagree on the marginal value of hydrogen and its aafety. Hydrogen is perfectly safe as a fuel if handled properly. Hydrogen using a sufficiently low cost solar power system may be made available at costs competitive with existing fuels.
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>> A ton of hydrogen has the same heat value of 6.2 tons of coal.
>
> And the volume of these at STP is ?
>
> Graham

That is a singularly dumbass question. To see why this is so, lets go over some of the basics of volumetric and gravimetric energy density.

Volumetric energy density is how much energy you get per unit volume.
Gravimetric energy density is how much energy you get per unit weight.

Standard Temperature and Pressure doesn't impact the volume of coal. The specific gravity of bituminous coal is 1.32 − so, 1 cubic meter contains 1.32 metric tons. Ground into a powder, its lower. So, the volumetric energy density of coal is typically less than 30 gigajoules per cubic meter. Lignite which can be 60% water and 30% carbon can have volumetric densities of 12 gigajoules per cubic meter.

STP doesn't impact oil either. Crude oil has a specific gravity of 0.76 to 0.83 depending on where its drawn from. Crude oil contains 41.7 Gigajoules per metric ton, so a cubic meter of oil is typically less than 32 gigajoules per cubic meter.

STP doesn't impact methanol. Methanol has a specific gavity of 0.79 and a gravimetric energy density of 19.7 gigajoules per metric ton, so it has a volumetric energy density of 15.6 gigajoules per cubic meter. At STP methanol is a liquid. Howaver at 64.7C methanol boils, and becomes a vapor. At that temperature it around 2 kg per cubic meter − 500 cubic meters are needed to contain a ton at that temperature and atmospheric pressure − so, a cubic meter of methanol vapor contains 0.394 gigajoules of energy.

So, we can see gases are a different story. So, lets look at that since hydrogen is a gas at STP.

STP is a valuable reference point,when tallking about gases, but tells us nothing about how to use a gas efficiently.

Natural gas and hydrogen gas are interesting to compare for this reason.

Natural gas has an energy density 53.6 gigajoules per metric ton, and at STP contains 0.05 gigajoules per cubic meter − more than methanol vapor at its boiling point − since 1072 cubic meters are needed to contain a ton at STP. Even though the density of natural gas at STP is less than methanol vapor at methanol's boiling point and both at the same pressure −natural gas contains more energy per unit volume than methanol.

Of course, natural gas is more typically used at 200x atmospheric pressure 10 gigajoules per cubic meter iare achieved − which is sufficient to provide efficient distribution and storage of the gas and approaches 1/3 the volumetric energy density of crude oil and 2/3 the volumetric energy density of methanol in liquid state..

Hydrogen is even less dense than natural gas − but is more compressible. Hydrogen gas has an energy density of 143 gigajoules per metric ton. At STP a metric ton of hydrogen occupies a whopping 8,576 cubic meters − so hydrogen's energy denisty at STP is only 0.017 gigajoules per cubic meter of the gas.

Obviously, as with natural gas, hydrogen is stored and transmitted only in a highly compressed state.

At the pressures established by the American Society of Mechanical Engineers for hydrogen, 4.3 gigajoules per cubic meter are achieved. Hydrogen's lower viscosity, means that the same sort of pipeline and storage infrastructure efficiently transmits the gas to stationary users on a national scale.

http://www.mac.doc.gov/china/Breakout%20D%20−%20Frikkin.pdf

In liquid form hydrogen achieves energy densities of 10 gigajoules per cubic meter equal to that of natural gas and 2/3 that of methanol. Which makes this liquid ideally suited for mobile applications where clean exhaust is desired.

Gelled and slush mixtures of solid/liquid hydrogen can provide further density increases.to 12.5 gigajoules per cubic meter − nearly half that of crude oil and nearly that of methanol.

http://www−formal.stanford.edu/jmc/progress/hydrogen.html
http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1T−3YDG9GM−K&_user=10&_rdoc=1&_fmt=&

Which is why major manufacturers are building experimental vehicles that burn liquid and gaseous hydrogen

http://www.bmw.com/com/en/insights/technology/efficient_dynamics/phase_2/clean_energy/bmw_hydrogen_7.html
http://www.flug−revue.rotor.com/FRheft/FRH9809/FR9809k.htm
http://www.sfu.ca/casr/ft−hdwpr.htm

The efficient storage, transmission and use of hydrogen in both stationary and mobile applications has been solved. Clearly anyone claiming otherwise is a throwback to an earlier time who is painfully ignorant of recent advances and current technical art on the subject.

The only issue facing humanity today is the efficient production of hydrogen gas. This involves two paths;

(1) the use of regenerative systems and low cost sources of renewable or nuclear electric power
(2) the low cost production of hydrogen from water using renewable or nuclear power
(a) thermochemical
(b) electrochemical
(c) combinations

http://www1.eere.energy.gov/hydrogenandfuelcells/production/water_splitting.html

Table of volumetric energy densities of typical fuels

Jet A Fuel 33.0 GJ/m3
Crude Oil 31.7 GJ/m3
Bit. Coal 30.0 GJ/m3
Methanol 15.6 GJ/m3
Gel H2 12.5 GJ/m3
Lignite 12.0 GJ/m3

Liq. H_2 10.0 GJ/m3
Nat Gas 10.0 GJ/m3 −at typical pressure
H_2 Gas 4.3 GJ/m3 −at typical pressure
Meth Vap 0.39 GJ/m3 − at methanol boiling point
Nat Gas 0.05 GJ/m3 − at STP
H_2 Gas 0.017 GJ/m3 − at STP

Obviously, hydrogen at STP is the lowest volumetric energy density on the list. Clearly anyone who argues from this fact that hydrogen is useless as an energy carrier is a fool. Hydrogen as a gel, as a liquid, and as a compressed gas, fares well against other energetic gases and liquids, and given the fact that its storage, transportation and use has been all but resolved, any talk suggesting this is not so is obviously ludicrous.

My solar panels produce hydrogen for $110 per metric ton − and using ASME standard infrastructure that hydrogen is delivered anywhere in a continental area on demand, for less than $200 per metric ton − making it competitive with all other primary sources of energy.

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