Re: Hydrogen Cars, Trucks, and Buses Are the Answer Indeed

Source: http://sci.tech−archive.net/Archive/sci.energy.hydrogen/2007−12/msg00139.html

- *From*: Willie.Mookie@xxxxxxxxx
- *Date*: Mon, 17 Dec 2007 16:47:32 −0800 (PST)

On Dec 18, 12:33 am, Eeyore <rabbitsfriendsandrelati...@xxxxxxxxxxx>
wrote:

> Willie.Moo...@xxxxxxxxx wrote:
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> > Eeyore wrote:
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> > > Willie.Moo...@xxxxxxxxx wrote::
> > >
> > > > In the 1980s steel manufacturers created new
> > > > alloy steels that were
> > > > specifically formulated to resist
> > > > embrittlement as stainless steels
> > > > resist corrosion. Both Lockheed and Boeing
> > > > explored the possibilty of
> > > > using thin sheets of this stuff to make liquid
> > > > hydrogen fuel tanks for
> > > > airliners and estimated costs of supplying
> > > > those airliners with
> > > > hydrogen.
> > >
> > > And of course hydrogen is completely unsuitable as an
> > > aircraft fuel since its VOLUME is some
> > > FOUR times that of kersosene.
> >
> > For fuels that you have to LIFT through the AIR its energy per unit
> > weight, not energy per unit volume that is the issue.
>
> Completely WRONG.

That's now what BOEING COMMERCIAL AIRLINE division had to say. Are you saying Boeing doesn't know shit, and you know more?

> The huge volume of hydrogen storage required for an airliner would either require a more massive structure (which itself is then much heavier)

You are the one who is wrong because you're not thinking about this clearly..

> or you would have less payload..

No, despite the heavier tank you'd actually have more payload or range, check it out.

Here are the energy densities and tank fractions for jet fuel and liquid hydrogen;

Jet Fuel: 42.8 GJ/tonne
Tank fraction: 1% fuel weight

Hydrogen 143 GJ/tonne
Tank fraction 10% fuel weight

This 10% fuel weight is DOUBLE what you find on liquid hydrogen rockets like the Space Shuttle and SIVB upper stage for the Saturn V rocket. So, we're really over−specifying the hydrogen tanks here.

So, this looks pretty bad for the hydrogen tank. That's because for a given mass of fuel your tank is TEN TIMES heavier carrying hydrogen around than carrying jet fuel around.

So, why is Graham wrong? Because he didn't complete his analysis and in the absence of completing his work he wrongly claimed hydrogen in infeasible by reason of that one numbers.

Obviously Graham is wrong since when you look at the fuel fraction of a long−range airliner like the Boeing 777−200 you have the following result;

http://en.wikipedia.org/wiki/Fuel_fraction

B777−200
Fuel Fraction: 47%
Take off Weight 298 tonnes

Jet Fuel Weight:140 tonnes

Tank Weight at 1%: 1.4 tonnes
Total Fuel System Weight: 141.4 tonnes
Fuel Energy; 5,992 GJ

Hydrogen Weight: 41.9 tonnes
Tank Weight at 10% 4.2 tonnes
Total Fuel System Weight: 46.1 tonnes

Jet fuel at $900 per tonne costs $126,000 per fill up.
Hydrogen at $800 per tonne costs $33,520 per fill up

http://www.usoal.com

So the total system, because of the higher energy density of hydrogen is LIGHTER DESPITE THE HEAVY TANK − which is nearly 3x heavier than the jet fuel tank despite carrying 1/3 the weight.

In fact the Boeing 777−200 powered by jet−fuel carries a payload of 57 tonnes

So we can say a jet very similar to the 777−200 massing a total of 298 tonnes when powered by hydrogen would carry 36 more tons of payload increasing the total to 93 tonnes− BECAUSE OF THE HIGH ENERGY DENSITY OF HYDROGEN PER UNIT WEIGHT.

Here are the two airplanes side by side

B777−200JF B777−200HF
Take off weight 298.0 tonnes 298.0 tonnes
Fuel weight: 140.0 tonnes 41.9 tonnes
Tank weight 1.4 tonnes 4.2 tonnes
Empty weight: 99.6 tonnes 158.9 tonnes
Payload weight 57.0 tonnes 93.0 tonnes

The empty weight does go way up for the hydrogen fueled version but that's needed to carry the extra 36 tonnes of cargo and passengers

> wouldn't be compatible with existing airframes.

Why? Because of volume? Well, lets figure that out;

Since the other part of this equation is total volume.

In the JF version of the B777 total tank volume is 117.3 m3. Fuselage diameter is 6.19 m and fuselage length is 63.73 m. So, total fuselage volume is 1,917.8 m3.

So, 117.3 m3 is 6% of the total fuselage volume. That's how big the jet fuel tanks are.

Now, at 70.3 kg per m3 the 46.1 tonnes of liquid hydrogen to give the Boeing 777 it range occupy 655.8 m3 of volume which is a total of 17.9% of the total fuselage volume.

By stretching the fuselage by 22 meters from 63.73 m to 85.73 meters − an adequately sized hydrogen tank may be added to the fuselage with very little change in overall vehicle dimensions or function.

The largest increase in weight is due to the cabin volume increase brought about by the massive increase in payload weight. That's a monumentally huge 63% increase in total payload for these 427.8 sq m wings. Why is that? Because cabin volume is LESS DENSE THAN LIQUID HYROGEN. Recall the last time you flew on an airplane. The greatest part of the fuselage volume was taken up by AIR − empty air − so people could sit, relax, convive, and generally carry on without too much cramp to their lifestyle. So, this is the real increase in volume, the volume needed for the massive increase in payload weight for the given wings.

There are two solutions.

1) Forgo the increase in payload weight and reduce the size of the wings by 28% for this fuselage, which reduces induced drag which reduces fuel requirements, which reduces fuel weight and tank weight, which incresaes payload (or calls for tinier wings) and allows operation at higher speeds.

2) increase the diameter and length of the fuselage by 21%. You're basically 180% larger volume when fuel and payload are considered − for the given lift capacity of these wings. Which means a fuselage that's 21% bigger in ALL dimensions. That's a fuselage that's 7.52 m in diameter − 1.33 m increase − and 77.52 m long (shorter than the stretched version described above and 13.79 m longer than the 777−200JF version)

This increases the frontal area by 47% and drag coefficient increases by that amount. INDUCED drag is the largest contributor at low speeds, and parasitic drag, at higher speeds − which is due primarily by the fuselage.

http://web.mit.edu/16.unified/www/SPRING/propulsion/Propulsion.pdf
(see page 19)

An analysis of the numbers for the Boeing 777−200 indicates a simple reduction in speed to 830 kph for the HF version with fat fuselage would produce the same total drag as the JF version operating at 905 kph. Obviously, as in case 1) above fuel volumes and payload volumes can be varied slightly to obtain the same range at the same speeds as the JF version.

The Boeing 777−200JF carries 24 first class, 54 business class, 227 economy class seats.

The Boeing 777−200HF (with enlarged fuselage − same wings) carries 40 first class, 88 business class, and 370 economy class seats.

Alternatively, one could carry 305 business class seats in the larger cabin and create a new class of service at lower costs for long−range travel − somewhere between economy and business pricing.

> Of course it would also guaranteee a collosal explosion even in the event of a crash you could walk away from today.

Nonsense. Real world data gathered with real liquid hydrogen tanks in real applications put a lie to this bogus statement

http://www.bmwgroup.com/bmwgroup_prod/e/0_0_www_bmwgroup_com/unternehmen/publikationen/aktuelles_lexil

http://www.bmwgroup.com/e/0_0_www_bmwgroup_com/unternehmen/publikationen/politikbrief/_pdf/PolitikBrief_2

Jet fuel is a liquid fuel that is handled as a liquid that has more or less a constant density with only slight variation in temperature and pressure.. This means as the tank empties fuel vapor and air mix above the tank and create an explosion hazard! This is a huge problem in aircraft which have been known to blow up without any reason because of a frayed wire passing NEAR a fuel tank.

http://www.iasa.com.au/folders/Security_Issues/CI−166recordersfound/CI−166recordersfound.html

http://en.wikipedia.org/wiki/TWA_Flight_800

http://www.galcit.caltech.edu/EDL/projects/JetA/misconceptions.html

http://www.geocities.com/freedomofpress/stratfor1.htm

http://www.newscientist.com/article/mg17623630.400−warplane−system−could−cut−midair−explosions.html

Liquid hydrogen is a cryogenic gas and a liquid hydrogen tank is a cryogenic dewar that is tightly sealed against the environment. As the tank empties, gaseous hydrogen fills the void totally, and no explosion risk is present inside the tank. In fact it is very much like the warplane system tank called for in the last pointer above.

Generally speaking because of the nature of liquid hydrogen and its cryogenic storage method, engineers can work out methods to make hydrogen fuel tanks far safer than jet fuel tanks − with the addition of blow lines, boil off pipes and so forth.

That is, Graham has it backwards, jet fuel CAUSES crashes that you'd never have in a cryogenically powered system.

BMW has created a stainless steel dewar system for their line of hydrogen cars that is is far safer than any gasoline tank ever built − and comparable features in any hydrogen fuel tank in an airliner would also allow for greater safety there as well.
.

> Hydrogen is a very very stupid fuel for transport applications.

No its not. You have failed to come to a proper conclusion on any point you raised, so this overall conclusion is bogus. In fact, your analysis is shallow and at best incomplete. In short you're a dumbass who doesn't know what the f**k he's talking about when it comes to hydrogen.

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