Re: Best Books on Hydrogen Future Possibilities

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- *From*: Willie.Mookie@xxxxxxxxx

- *Date*: Sat, 5 Jan 2008 20:44:44 −0800 (PST)

On Jan 4, 10:06 am, Don Lancaster <d...@xxxxxxxxxx> wrote:

> Gary wrote:
>
> > I'm a total layman / novice. But for some reason I find myself thinking a lot about the possibilities of hydrogen.
> >
> > I'd like to get some books that explain the possibilities and obstacles for hydrogen. I'd like to avoid anything that is all hype but also avoid books that can't imagine a future that doesn't exist yet. Not looking for anything too technical, but I'm not stupid either, so if there is a little background in the chemestry needed to explain things, that't fine too.
> >
> > So, suggestions for the best books?
> >
> > Thanks,
> > Gary
>
> Here are the arguments against the hydrogen economy:

If they're listed below, they're bogus arguments.

1. Terrestral hydrogen is ONLY an energy carrier or transfer media and NOT a substance capable of delivering net NEW BTU's to the on−the−books economy.

By this accounting natural gas coal and oil are energy sinks since

they too are energy carriers made by ancient biomass that no longer exists and cannot be replaced once burned. That is, every BTU of energy released by burning coal, natural gas and oil irretrievably diminishes the fixed supplies of the stuff made by ancient sunlight. So, by this accounting hydrogen made from water and sunlight by solar panels and electrolyzers is far superior than coal, crude oil, and natural gas made from sunlight, water and carbon by ancient biomass that no longer exists.

2. Terrestral hydrogen creation is inefficient as considerably more energy of usually much higher quality has to be input than is eventually returnable.

By this standard terrestrial sources of coal oil and natural gas is woefully inefficient and takes astronomical amounts of energy of very high quality than is returned. Consider that to make a ton of coal likely involved the processing of over 10,000 tons of ancient biomass fed by sunlight water and carbon sources and further by geological processes over millions of years to form. There is no way to efficiently replace a ton of coal once it is burned. Not so a 140 kg of hydrogen − which has the same heat value.

3. No large terrestral source of hydrogen gas is known.

Yes there is − its called the HYDRO−sphere − aka the world's oceans − and for each ton of recoverable carbon there are tens of thousands of tons of recoverable hydrogen from this source.

Water, of course, is a hydrogen sink

This is a mischaracterization based on faulty analysis. Hydrogen is produced today in laboratories and in fertilizer plants around the world by a wide variety of means. Some involve electrolytic decomposition of water to form hydrogen. Other processes involve the shift reaction of water with carbon to form hydrogen. In all cases the source of hydrogen is the same − water.

and, by fundamental chemical energitics, is the worst possible feedstock.

Another mischaracterization based on faulty analysis. Applying the same analysis to the PRODUCTION of coal, crude oil and natural gas by the action of sunlight on ancient biomass, produces the result that water produced by electrolytic decomposition of water where the electricity comes from solar wind nuclear or hydropower is VASTLY superior to processes that no longer operate and are incapable of replacing ANY of the coal crude oil and natural gas that's consumed.

This inability to replace coal crude oil and natural gas is the reason for the price rises in these products over time.
These price rises are the only way the owners of a declining asset can improve their profits.
An effcient effective alternative to crude oil natural gas and coal puts downward pressure on rising prices.
Obviously, those who own fossil fuels would not want to see a hydrogen economy arise until AFTER ALL the fossil fuels were sold.
Plainly, it is in the public interest to see strong competition emerge between fossil fuels and alternatives to fossil fuels.

The world recently consumed 28.3 billion barrels of crude oil each year, 5.5 billion tons of coal each year, and 2.2 billion tons of natural gas each year and produced over 40 billion tons of carbon dioxide. 98 TW of solar panels, covering 554,000 sq km of desert lands are capable of converting 30 billion tons of water into 3.34 billion tons of hydrogen gas and 26.66 billion tons of oxygen each year − this much hydrogen gas displaces ALL the fossil fuel use, and ELIMINATES ALL the carbon production on the planet without reducing the energy usage of ANYONE. At a cost of $0.07 per peak watt, including electrolysis unit, this infrastructure can be easily built on existing strip mines in desert regions and produce great profit while reducing energy costs of everyone. The ultimate win−win scenario.

4. The CONTAINED energy density

Please define this term. I checked with ASTM Technical Handbook of Engineering and Scientific Definitions and found it did not exist as a real technical term. So, please clearly concisely and plainly, define this term. Otherwise, its just bullshit.

of terrestral
hydrogen by weight is a lot LESS than gasoline.

Which is very important in aircraft and mobile applications where hauling weight around reduces vehicle performance.

> And drops dramatically as the tank is emptied.

This is true as ALL tanks are emptied! haha.. I can't believe Don is talking about this like its some sort of important technical detail. Here's what he's talking about. You fill a 20 gallon gas tank with gas. 20 gallons contains about 2.4 GJ. Right. So, you run the tank down to 1 gallon and burn off 19. But the EMPTY tank still COULD hold 20 gallons. So, the contained energy of the tank is still 20 gallons. So a 20 gallon gas tank only has 0.12 GJ − haha.. what a trip. Fact is, ALL tanks as they are emptied CONTAIN less energy. Why would you expect hydrogen tanks to shrink as you empty them? It doesn't make sense.

> The energy density of hydrogen gas by volume is a ludicrous joke.

This is an emotional, not a technical logical or rational argument. Fact is, the energy density of hydrogen is 1/3 that of gasoline. This is true. But the weight is like 1/10th that of gasoline. SO, you only have to carry about 1/3 of the weight around. This is a good thing. The question here should be, is hydrogen worth the effort? The answer is YES! Why? Because the weight of gas in a car is something like 5%. The volume is something like 3%. The tank weight is something like 2% of the weight of the gas, so its 0.1% the weight of the car. In an airplane, the weight of the gas, can be as high as 47%, the volume something like 15%, the tank weight 1% of the gas weight or 0.05% of the weight of the airplane. Okay, now switch to LIQUID HYDROGEN okay? Now, the weight of gas in the car is 2% for the same range and performance. The volume is something like 10% of the total − larger but not a huge problem. The weight of the tank for car applications is something like 20% of the fuel weight, so that's 0.4% of the total car weight. Again, not a big problem. In an airplane the difference is huge. Fuel weight drops to 15% of the aircraft, the volume increases to something like 45% of the aircraft − which entails increasing the size of the fuselage (Airbus and others have completed studies for this and these modifications are easily accomplished) − and the tank weight, which is 10% the weight of the hydrogen for aircraft use − is something like 1.5% of total takeoff weight. So we end up in cars, with slight improvements in performance or no change in structure, slight changes in tank placement and so forth. In aircraft we end up with MODERATE changes in fuselage dimension and MASSIVE IMPROVEMENTS in performance. None of this suggests that the use of hydrogen is a ludicrous joke, despite its low mass density.

> 5. Virtually all bulk hydrogen is produced by methane reformation. And thus is EXTREMELY hydrocarbon dependent.

Hydrogen made to produce ammonia for fertilizers and explosives use
the shift reaction or the reverse of the Sabatier process.

C + 2 H2O −−> CO2 + 2 H2 (shift reaction)

or

CH4 + 2 H2O −−> CO2 + 4 H2 (inverse sabatier)

The first uses coal, the second natural gas. That's because when
Haber developed the process for making Ammonia in 1911 natural gas and
coal were the primary sources of energy for the planet. In 2008
supplies of these fuels are waning. As a result other more efficient
processes were developed. These include;

Electrolytic reduction of water

2 H2O + 4e− −−> 2 H2 + O2

With electricity coming from nuclear sources, solar power sources,
wind sources, hydro−electric sources.

Thermolytic reduction of water

2 H2O + heat −−> 2 H2 + O2

With heat coming from nuclear reactors, solar power sources, or waste
heat from conventional generators.

6. Hydrogen has the widest explosive range known,

True. This means that it can burn under the same conditions as ALL
the following fuels;

Coal, natural gas, crude oil, crude oil products and
distillates.

This means that hydrogen can DIRECTLY REPLACE ALL THESE FUELS WITHOUT
ANY MAJOR CHANGE OF INFRASTRUCTURE. That is, you could burn hydrogen
in your car with slight changes. In fact, BMW, GM, Ford and others
have built hydrogen powered cars. NASA, Boeing, and others have built
hydrogen powered airplanes. Others have built hydrogen powered boats
− all very similar to todays fossil fuel versions − to demonstrate the
ease with which these engines can be made to use hydrogen.

the least spark energy required for ignition,

Not clear what is meant by 'the least spark' But to the extent Don is suggesting hydrogen is an explosive, he's wrong. Besides, its not true that Hydrogen + spark will not ignite hydrogen. Not true at all. Fact is, Hydrogen + spark + oxygen − MIGHT ignite hydrogen if it is mixed in the appropriate range to support ignition and the spark energy is sufficient. The spark energy to ignite hydrogen is sometimes less sometimes more than the spark energy for other fuels, depending on the fuel and the mix of oxygen and fuel and pressures and so forth − but generally hydrogen has the same spark energy range as any other fuel.

> and
> has no known colorants or odorants.

That's not true. In fact I posted on three separate occasions to Don's rants detailed peer reviewed articles that reported on a number of odorants and colorants that were used with hydrogen. The fact that he has quality information that is nearly 10 years old now, that describes in detail the efficacy of colorants and odorants used with hydrogen fuel, and he still repeats this falsehood, says a lot about Don's LACK of commitment to truth and accuracy. Shame on you Don for repeating this lie. It may have been true once, but as of 1998, it wasn't true.

> Its flame is
> often invisible or nearly so.

Depends on the details. The same can be said for a number of fuels, such as certain alcohols. So what? That doesn't stop alcohol from being used as a fuel, and it doesn't stop hydrogen either.

> 7. There is more hydrogen in a gallon of gasoline
> than there is in a gallon of liquid hydrogen.

The point of this statement is a mystery to me because it has nothing to do with hydrogen as a fuel. There' s more hydrogen in a gallon of water than in a gallon of gasoline. Yet there is NO useable energy gained from a gallon of water.

There are 264.17 US gallons in a cubic meter. The density of liquid hydrogen is 70 kg per cubic meter. The density of gasoline is 680 kg per cubic meter. The density of water is 1,000 kg per cubic meter.

Liquid hydrogen is 100% hydrogen by weight.

So, there's 70 kg of hydrogen per cubic meter of hydrogen,

Gasoline is 15% hydrogen by weight.
So, there's 680x0.15 = 102 kg of hydrogen per cubic meter of gasoline,

Water is 11% hydrogen by weight
So, there's 1,000 kg x 0.11 = 110 kg of hydrogen per cubic meter of water

What does this have to do with hydrogen as a fuel? Nothing!
What's important is the energy contained in each fuel and its cost and availability.

Hydrogen contains 143 GJ per metric ton, and is easily made from water by a variety of processes, can burn under all conditions other fuels burn, and produce no carbon emissions when burned.

Gasoline contains 46.9 GJ per metric ton, every drop is irreplaceable, burns under more limited conditions than hydrogen, and produces massive quantities of carbon dioxide sufficient to change climate.

Water contains 0.0 GJ per metric ton. there is tens of thousands of times as much water as gasoline, and water is a byproduct of burning hydrogen as well as a source of hydrogen.

8. No effective vehicle compatible means of hydrogen storage is known that is remotely as cheap, safe, dense, and convenient as carbon bonded hydrides.

This is true as far as it goes. This is a mischaracterization however if after reading this you believe that hydrogen can't compete with gasoline and its distillates. That's because the size, weight and cost of the fuel tanks in a vehicle drive train are very small parts of the total cost of that drive train!! As mentioned above, hydrogen vehicles have been built and operated and there appears to be no show stoppers to making massive use of hydrogen once adequate supplies are made available by investing in the needed technology to make those supplies from abundant water and sunlight.

9. No infrastructure exists for gaseous hydrogen distribution.

Hydrogen distribution systems have been in use since 1911. In Canada and Europe, since the 1950s saw large pipelines built by the chemical supply and fertilizer industries which allow cheap effective transmission of hydrogen gas across continents. In 2006, after much

delay, the American Society of Mechanical Engineers (ASME) completed their standards for hydrogen infrastructure. It is now possible to specify to any qualified supplier any component needed to store and distribute hydrogen on any scale needed.

> Pipelines in particular raise major density and embrittlement issues.

When Haber built his first hydrogen production system in 1911 to make fertilizer, he noted that hydrogen caused embrittlement in certain types of steel. He ranked this in importance as LESS troubling than other challenges pipelines have, such as corrosion. In 1958 when NASA was building its infrastructure to supply hydrogen fuel to its deep space rockets and moon rockets, embrittlement was noted as a contributing factor to its high cost relative to liquid oxygen. Despite over a decade of use of this infrastructure, no failures, accidents, or troubles were found in its operations despite sending tens of thousands of tons of hydrogen off world. As mentioned above, in 2006 ASME completed standards for the hydrogen economy. These techniques created in the 21st century produce systems that are vastly more reliable, cost effective, trouble free, and safe, than the ancient methods of handling and transporting fossil fuels developed in the 19th century. That is why today despite nearly a decade of industrial use, you have never seen a pipeline accident, or shipping accident with hydrogen yet these accidents routinely occur in the shipping and handling of fossil fuels.

> 10. Electrolysis from high value sources such as grid, wind, or pv is totally useless as a hydrogen source because of the staggering loss of exergy.

Exergy is not defined in ASTM handbook of technical and scientific terms. Please clearly and concisely, with a formula, define what you mean by exergy? Give me a clear cogent example of its use and why its relevant?

Barring that, Don seems to be saying that electricity is more valuable than hydrogen. That depends on the details. For example, certain types of generation capacity produce when there isn't demand to accept it. A hydro−electric dam that has a lot of water behind it from a rain fall − needs to be emptied in the dead of night when there isn't any demand for electricity. A nuclear power plant that can't easily change its output, and doesn't change its cost hardly at all with changing output, produces more electricity than is needed in the dead of night. A wind generator is producing lots of electricity when the wind is blowing, but the capacity isn't needed right now. A solar generator is producing lots more electricity in the day than the grid

needs.

ALL these examples involve WASTING energy, dumping water over a dam without generation, grounding the output of a nuclear plant to balance the grid, taking the solar panels or wind generators off grid, or alternatively, grounding out other generation that cannot be easily cut back... ALL these would BENEFIT from STORING the energy somehow. That is, this electricity isn't the same as highly valued electricity. So, this electricity is conveniently used to convert water into hydrogen and oxygen.

> There ALWAYS will be more intelligent things to do with the electricity.

Depends on the details. The owners of the hydro−electric dams, on both sides of the border, have excess capacity at night. That's why they have been seriously contemplating the production of hydrogen gas from water, and the shipment of liquid hydrogen from the site to sites in Europe.

> 11. Improper burning of hydrogen produces highly polluting nitrous oxides.

Imrpoper burning of ANY fuel produces highly polluting nitrous oxides. Don again is stating something that is true, but in a way that mischaracterizes reality, if you come away thinking that hydrogen properly burned, produces MORE nitrous oxides than other fuels. In fact it does not. While it is true that its very easy for hydrogen to burn hotter than other fuels, and thus produce nitrous oxides, its also true that hydrogen being far simpler and more explosive than other fuels, when properly burned in an appropriately designed burner, produces LESS nitrous oxides than other fuels produce. Airbus and others that explored the changes one could make in burner design of jet engines needed to support a hydrogen fueled airliner, found that when they tested hydrogen in modified engines on the bench in 1998, they produced 1/40th of the nitrous oxides that today's jet engines produce.

> 12. Terrestrial hydrogen is basically a POLLUTION AMPLIFIER that INCREASES the pollution of its underlying sources.

Generally speaking this is not true. Even if we use hydrogen made by the dirtiest process known, the carbon shift reaction, where 11 tons of CO2 is produced by each 3 tons of carbon and 9 tons of water to

produce 1 ton of hydrogen − sequestration of the carbon dioxide at the point of production is particularly easy to achieve.

When one considers sources of hydrogen where there is no pollution whatever in the underlying source − say the hydroelectric dams of the Niagra river − NO pollution is produced whatever. zero times any number is still zero.

> It is utterly ludicrous to
> claim that hydrogen is in any manner, way,
> shape, or form "nonpolluting".

Not true. Hydrogen is the least polluting of all fuels we can imagine. When burned properly it produces less NOx than produced by properly burned fossil fuels. When burned it produces NO carbon emissions whatever. When produced from carbon sources that sequester the carbon emissions, or when produced from electrical sources that HAVE ZERO carbon emissions, the production of hydrogen is nonpolluting. The burning of hydrogen produces water, which can again be used to store energy − which is the basis of regenerative systems, now being flown on solar powered aircraft, and automobiles. The burning of fossil fuels reduces the amounts of irreplacable hydrocarbons that are better used to make plastics and other high value goods.

13. Hydrogen rots most metals through embrittlement.

Rot is a non technical high pejorative term. It is true that certain metals cannot be used with hydrogen. Just as certain materials cannot be used with crude oil distillates. The ASME specifications for a hyrogen economy detail cost effective, reliable, safe, and easy to use, procedures to store, transmit and use hydrogen on an industrial scale that exceed the standards of safety and reliability of anything achieved in the fossil fuel industry. For example, gaseous hydrogen tanks built to spec last over 60 years. No other tank as reliably and safely fulfills its role as hydrogen tanks do.

14. "Carbon Neutral" solutions would appear better
than "Carbon Free" because

Please explain Carbon Neutral? The dirty little secret of the carbon neutral movement is that it does very little to actually change our carbon impact, while giving major coal natural gas and oil industries a fig leaf of cover to continue polluting the planet. I saw an ad on the side of a bus in Australia the other day from BP. It said that

this bus was carbon neutral. Why? Because natural gas the bus burns produces SLIGHTLY LESS carbon than gasoline or diesel fuel. And no particulates. This slight advantage per unit energy allowed BP through fancy accounting to say that about 10% of the buses that burned natural gas were 'carbon free' because 10% less carbon was emitted. They avoided the fact that 90% of the carbon was emitted before as after − and this may be an over−estimate. Because talking to the bus drivers, natural gas powered buses underperform compared to their gasoline cousins − and so, in operation, they may take more than 10% of the time to climb a hill, or navigate a difficult terrain − and their actual emissions may not be less at all.

Bottom line, a highly theoretical calculation of carbon savings is spun in a way to suggest that ALL the buses are carbon neutral − when in fact, only a small fraction − if any − are.

> (A) A significant
> measure of the energy of most fuels is in its carbon
> fraction,

Most fossil fuels sure. In hydrogen there is NO carbon − which is the point.

> (B) Carbon appears to be essential for
> convenient and safe room temperature liquids,
> and

Gasoline and jet fuel are room temperature liquids. They are not particularly safe, as owners of the Ford Pinto, or passengers on TWA 800 found out. Gasoline is not particularly convenient, given the number of cancer and lukemias caused by the fumes, the number of deaths and disfigurements due to fires and inhalation, and the amount of environmental damage leaky tanks and spillage cause to ground and water.

> (C) Reformation is not required or else
> is simpler, cheaper, and wastes less energy.

Not clear if Don is talking about chemical reformation of methane or reformation of our energy system to use hydrogen. In any case, the market will adopt a more efficient solution if the restrictive regulations that prop up the oil coal and gas industries are removed to allow alternative energy companies play on an even playing field. For example, regulate liquid and gas emissions from oil and gas wells and coal mines, the same way they're regulated from your tail pipe.

The market would freely adopt the better solution.

CHeck it out. The world spent $4 trillion last year to buy 28.3 billion barrels of crude oil and distillates, 5.5 billion tons of coal, and 2.2 billion tons of natural gas. These were burned and produced over 40 billion tons of carbon dioxide. ALL this fuel could be replaced with 3.34 billion tons of hydrogen made from 30 billion tons of water using 98 TW of solar panels covering 554,000 sq miles at desert strip mine sites at a cost of $800 per ton − which totals $2.67 trillion dollars per year − a substantial savings over existing systems

> 15. An optimal hydrogen storage solution exists by carbon bonding as in heptane or iso−octane.

So? This actually reduces the energy in hyrogen. As you pointed out above, MOST of the energy comes from carbon in these materials. These materials when they occur naturally, are the result of sunlight being captured by ancient biomass which is then processed geologically and discovered by those looking for them underground. That means these materials are IRREPLACEABLE. BURNING them increases their demand and value to their owner, but it ELIMINATES them from ALL FUTURE USE. This is a HUGE WASTE OF RESOURCES to satisfy the greed of the present day owners. The use of fossil fuels should be restricted to use in plastics, carbon composites and similar uses. Hydrogen should be adopted whenever possible.

> Both
> of these room temperature liquids ain't broke.

Residual oil, used in certain power plants, must be heated to be pumped through the system. Jet fuel sitting in fighter jet tanks and airliner tanks in polar regions, like Anchorage Alaska, must be pre−heated to opereate in the jets. Since when is room temperature operation a requirement? What is the rationale? Fact is, there is non. Gaseous hydrogen tanks operate at room temperature. Liquid hydrogen tanks do not. So what? What matters is the safety reliability cost and ease of use of the fuel. Hydrogen is adequate on all these counts, there is nothing fundamentally wrong with hydrogen. Hydrogen ain't broke either.

On the other hand, coal, natural gas, and crude oil, have value beyond their heat value. They are very limited when compared to the availability of water and sunlight. If you burned all the oil coal and natural gas recoverable in the world today in a big bonfire, you would equal the amount of energy falling on the Earth for 1/5th of a

second. About the time it takes you to blink. There is no known process to recreate coal, oil or natural gas as cheaply and conveniently as it can be produced from known reserves. Hydrogen gas made from low cost solar panels and water, competes head to head price wise and in every other way against these other fuels. The value of these carbon materials to future generations in inestimable. Today we know how to make plastics, fertilizers, explosives, carbon fibers, nanotubes, with these carbon sources. In the future, we will know more than we do today. The value of these materials will be higher in the future than they are today. These on a weight or volume basis are dozens to millions of times more valuable than their use as a fuel. It is obviously massively wasteful to burn something that is irreplaceable as a fuel, when it can have more value in the future as a constructive material. We are robbing future generations of these valued irreplacable substances whenever we burn a tank of gas or a ton of coal. Furthermore, we are CAUSING massive climate change and hurting future generations that way. Fossil fuels ARE broke, and have been broke for a long time. Hydrogen ain't broke, and all the elements are coming together for a massive shift in the way people use energy − moving away from the things that are broke, and toward the things that are not.

> −−
> Many thanks,
>
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>
> Please visit my GURU's LAIR web site athttp://www.tinaja.com− Hide quoted text −
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Don, we have had this conversation before. You have not usefully responded to anything I have pointed out here. You have not even acknowledged well known facts that put the lie to many of your statements. You are certainly not a dumb or foolish person. But, increasingly it appears, you are a dishonest one. That's too bad.

But you can change this. Acknowledge that ASME has indeed adopted standards that allow the production, storage and transmission of hydrogen on an industrial scale that are far safer, more reliable and easier to use than any comparable system used by the petroleum and natural gas or coal industries. Acknowledge that nearly all of your points are red herrings that have little or nothing to do with practical efficient systems. Then, maybe you can restore a little of the trust you have lost with this massively dishonest post above.

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