Re: On Hydrogen Fuel

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- *From*: "H2−PV NOW" <H2.PV@xxxxxxxxxxx>
- *Date*: 20 Feb 2006 21:15:58 −0800

tomcat wrote:

> H2−PV NOW wrote:
>
>> Probably has to do with the glass lining, don't you think? If it wasn't a vacuum seperated bottle in a bottle, then convesctive and conductive heat gain would be high. The coldness of the LOX would promote thick frost/ice accumulation on the tank outer surfaces leading to both aerodynamic drag and ice chunk falling hazards.
>
> NASA seems to be having a problem with tank ice on the Shuttles. In my judgment it is best to put the tanks within the body of the vehicle, not attach them to the belly.

Look at that big external tank that the shuttle and two solid rocket boosters are strapped on. Now WHERE INSIDE do you fit that?

>> It increases it due to the fact that a leaner fuel mix is used. Perfect combustion of H2+O2 to H2O cannot be counted on due to the short latency time in the combustion chamber. LH2/LOX is burned at a 1:4 ratio instead of 1:8 ratio by mass/weight. With Slush−LH2/LOX the H2 is birned at a 1:6 ratio, a 50% improved fuel efficiency. The Isp remains constant as only the reaction of 2H2+O2=2H2O counts. None of the unburned H2 adds thrust.
>
> Rocketdyne says that the SSME is 99% efficient. I don't know what that figure is based on but I don't think it really means that 99% of the fuel is converted to energy. More efficient combustion of the LH2/LOX mixture may be called for.

You are misunderstanding what is meant by efficiency. H2 can only burn when it finds O2. In the tiurbulent gas streams and combustion environment it gets a very short amount of time to do that.

Theoretical efficiency is 100% if every molecule of H2 finds an O or O2 the mate up with. Because of the short latency time in the combustion chamber that 100% fuel efficiency is not possible. "Rich" mixutes of fuel and oxidizer means that there is extra fuel in the mix looking for O2 partners and the chances of finding them are increased. LH2/LOX rockets typically have double the H2 component, 4O per 1H, wasting 50% of the fuel as unburned expelled molecules in the rexhaust stream. Slush/LH2 only wastes half of that, for a ratio of 6O per 1H ratio.

The goal is not to conserve fuel, but to get sufficient power, in the short time that it will do you any good. Efficiency, then is getting all the power you possibly can in the short latency time that fuel and oxidizer are lingering in the combustion chamber. If they burn downstream you get no lift from that.

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> One way to 'slush' LH2 is to allow rapid evaporation of the liquid in a vacuum. Since rocket tanks are vented a similiar condition must exist in the vacuum of space. Also, liquid helium is used to provide pressuriziation gas for the tanks. Since liquid helium is colder than liquid hydrogen this would tend to 'slush' the tanks too.
>
> It may very well be, therefore, that rocket tanks exposed to space gain a substantial performance boost due to 'atomic' hydrogen atoms fusing together on combustion. Also, the helium gas present will greatly expand. In this sense, the helium is not inert.

I think you are over−estimating the virues of "atomic" hydrogen. Fuel cells reduce hydrogen to atomic form through catalysis, and they do it quietly, efficiently, and non−spectaularly. Fuel cells are not rocket engines because of some magic property of atomic (non−molecularly bonded) hydrogen.

Instead of trying to squeeze more power out of hydrogen as a fuel, stop making it work so hard and accomplish more. The problem is NOT that hydrogen is not giving lots of power already −− the problem is it is being asked to lift 8 to 16 times its own weight in oxidizer from a dead stop under the thickest part of the atmosphere.

That's the problem to solve: how do you avoid the weight and volume penalty of carrying 8 to 16 times the fuel mass (of oxidizer) until you are clear of 90% of the atmosphere? SKYLON and SABRE claim they are solving that problem by air−breathing up until they are at Mach 5.5, and filling their LOX tanks at high altitude from the thin air at high speeds.

It's a very intelligent approach. Unfortunately the math is not that clearly on their side. In order to chill air to LOX temperatures they need additional LH2, which is colder, but not that much colder than LOX. Air is 90% N2, which will drain heat from LH2 without contributing any lift, so the N2 has to be jettisoned with it's chill subtracted from the LH2. The process of seperating O2 and N2 has to occur very fast or else too much LH2 is being lost, and the take−off LH2 load begins to get too big and too heavy for the mission objective, which is to reach LEO as a Single−Stage−To−Orbit vehicle.

The margins are slim. The allowable time window is narrow. The technology must work perfectly and it must work extremely well.

For these reasons, plus the small cargo payload, SKYLON does not look like a useful answer even if it does work as advertised.

> The concepts of 'atomic' hydrogen fuel may have already been proved in Outer Space on various flights. It might have resulted in mysterious power increases on LH2 engines. And, if this is the case, it may have also proven that current engines, such as the SSME, are capable −− without modification −− of handling the increased stress of 'atomic' hydrogen fuel.

There's no such thing as "Leprechan Hydrogen", some magical hydrogen that is different from the ordinary kind. Hydrogen as H2 is more compact than hydrogen as H+H atomic non−molecular form. I don't care if you freeze it into bricks, the molecular form has reduced in size from atomic solitaires. Atomic H is very unstable and seeks the first form of stability as H2. This is an exothermic chemical reaction that liberates heat energy which causes a chain reaction that causes all the H to form H2, but now highly excited by the thermal energy released. Heat turns to kinetic energy which becomes expansion and pressure energy and the end of that is ruptured tanks, death and destruction.

For WHAT? So you can avoid looking at the real problem of trying to lift too much oxidiser from a dead stop under the thickest atmosphere?

SKYLON is not the best answer, but it is far better than trying to lift too much oxidizer in the first place.

The first place SKYLON can be improved is with much bigger wings. NASA Helios prototype flew to 100,000 feet in 2001, the same altitude that SKYLON picks up its oxygen supply, but the Helios got there on big wings with 28 horsepower of electric motors. Those electric motors were powered by solar cells,

There are several proposals to launch from 100,000 feet from platforms, including an unmanned kite, and one proposal to launch from balloon.

Stop asking Hydrogen to lift backbreaking loads all on it's own. It can't do more than physics allows and Leprechan Hydrogen found in a box of Trix is not any kind of answer.

Shed the weight. Use the air for lift. Take on the oxidiser at the last altitude there still is plenty. Be already going fast when you load the oxidizer. Begin going fast after 90% of the air is below you. Hydrogen can do this much and no more. Settle for what the laws of physics says is the limits.

The Shuttle costs $10,000 per pound of payload delivered. Accept it that is too high a price to pay. "Atomic" hydrogen is not cheaper, but it's more deadly, for no important gain in trading dihyfrogen for monohydrogen.

> We may, indeed, be very close to actually utilizing the new NASA 'atomic' hydrogen fuel, which is just the next step beyond 'slush'.

So what? You pay $15,000 per pound to orbit instead of $10,000 and get lots more crashes on TV to talk about.

The problem is not that Hydrogen is not powerful enough already. The problem is we are loading it down with too many burdens to carry. If you want $10 per pound payload to orbit you have to shed the weight, you have to let the Earth's low altitude air carry some of the weight, and you need to load the heaviest part of the fuel supply after the air is very thin, and do this when you are already moving faster than non−astronauts move through the air.

You are redesigned a fine fuel instead of redesigning a fat pig of a ship. Even NASA has given up on the Shuttle. It never did what it was created to do: frequent, regular, low−cost, routine flights to LEO with a cargo equivilent to a highway truck load. Even if the external tank was half as big, filled with twice as powerful Leprechan monohydrogen, there would still be two solid rocket boosters strapped on. The LH2/LOX external tank is not recovered, and it's cost is not the main barrier from meeting the objectives: frequent, regular, low−cost, routine flights to LEO with a cargo equivilent to a highway truck load.

The thing that is strapped to the tank is the problem, and nothing you can do to that tank and its contents will change the thing strapped on it.

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