Re: Modest Proposal − Common Interplanetary Booster

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- *From*: Willie.Mookie@xxxxxxxxx
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Brad, your reply makes no sense whatever. You just say the same offensive things regardless of what is said. I guess those things must've tested well in audience testing hunh? lol.

Fact is, the idea of using Mars water and a solar or nuclear power source to process water into hydrogen and oxygen, provides a means to send an additional 600,000 lbs to Mars − nearly the entire stage weight! Especially if oxygen is derived from water or CO2 for breathing. Pressurizing the mars atmosphere to grow crops would also be interesting.

A person takes 2 lbs of oxygen per day on average. That's about a liter of water per day. That's 15.8 MJ per day. That's about 184 watts continuous. Four 300 Watt solar panels (power rating at Earth) and intertie, and a laboratory electrolyzer − to generate enough power at Mars to provide the oxygen needed by an astronaut! The astronaut could breathe indefinitely with a water supply!

Another possibility is to pressurize the Mars atmosphere using a molecular sieve or a cryogenic separator to separate out the 0.13% oxygen and then compress it.

This requires that the 0.60 kpa atmosphere be pressurized 27,000x Mars pressure with everything but oxygen filtered out.

Nitrogen would only need to be be pressurized 4,500x to have the same ratio of oxygen and nitrogen as on Earth;

The energy needed to compress is not less than

W = nRT*ln(Pa/Pb)

Pa/Pb = 27,000 −−> ln(Pa/Pb) = 10.2
2 pounds of O2 gas molecules 28.4 moles so n 28.4
The temperature of the Mars atmosphere ranges from 133K to 293K − lets say an average of 220K
R is the rydberg constant and that's 8.314 J/(K*mol)

W = 28.4 * 8.314 * 220 * 10.2 = 530 kJ for the
oxygen/day

That's 6.13 watts!!!! A hampster in a cage could generate that!
lol.

Pa/Pb = 4500 −−> ln(Pa/Pb) = 8.4
The nitrogen n=74.6 moles
T and R the same

W = 74.6 * 8.314 * 220 * 8.4 = 1,146 kJ for the
nitrogen

Since the nitrogen is not consumed, you could take two days to pressurize it and it would take only 6.6 watts − that is the same system with a different filter would pressurize nitrogen in the same atmosphere to Earth normal pressure, in two days, and keep it there.

Water vapor in Mars' atmosphere is 0.03% in Earth's atmosphere its 1% − this means that to attain the same level of water vapor in a synthetic atmosphere as seen on Earth the water vapor must be separated and compressed 5,700x

Pa/Pb = 5700 −−> ln(Pa/Pb) = 8.6
n=0.02 − for the combined Nitrogen and Oxygen
T and R the same

W = 0.02 * 8.314 * 220 * 8.6 = 0.3 kJ for the water
vapor (at 1%)

This is trivial = 3.63 milliwatts!!!

This is telling us we can mine water from Mars' atmosphere very easily!! At 6 watts we can get 2000X at much water as needed to make the atmosphere as moist as Earth's this means liquid water is easily obtained.

A single 300 watt solar panel with a molecular sieve and compression pump, supplies 50 people air and water directly from Mars' atmosphere.

Is this right? Even if the molecular sieve introduces a 50% loss, this is a remarkable calculation if I haven't made a mistake.

A simple pump would pressurize a PET film to pressures where crops and people would easily survive.

Plants may not need much. Earth's atmosphere is 101.3 kpa and Mars' atmosphere is 0.60 kpa on average. That's 0.59% partial pressure..
Mars' atmosphere is 96.5% CO_2 − so the partial pressure of CO_2 on Mars is 0.57% of Earth's atmospheric pressure. Earth's atmosphere on the

other hand is 0.0384% of teh total, which makes Mars' atmosphere nearly 15x more abundant in CO_2 than Earth's even at the low pressure found naturally. So, why pressurize for plants? To get liquid water! Water cannot occur as a liquid at the pressures found on Mars. Triple the atmospheric pressure, without filtering and you have 45x more CO_2 than found on Earth and sufficient pressure to liquefy water − so plants can transpire it.

Assuming we've got plants growing at this lower pressure, producing oxygen at the same rate its being consumed by humans,

Pa/Pb = 3 −−> ln(Pa/Pb) = 1.1
n = 39.1
T and R same

W = 39.1 * 8.314 * 220 * 1.1 = 78.7 kW

Power is 918 milliwatts!!!!

So, compressing Mars' air 3x under a dome of thin film of PET to grow plants, and compressing THAT air (enriched in O_2 and water) as described to produce Earth normal pressure and copious water for human use under a separate dome − is easily achieved with very little power indeed.

To heat the air is simple. Compress it and use a heat exchanger to warm the discharged air after separation. It is only needed to raise the temperature to 300K which gives the ratio of buffer gases needed for a given insulating factor for the PET film. A layer of stagnant CO_2 trapped in inflatable layers, with an appropriate IR reflector should keep the temperature within a comfortable zone with very little external power input.

If there isn't a major error in calculation, it seems with a very modest setup we could recharge our air and water supplies for the return journey home using quite modest power supplies − and with seeds, perhaps even FOOD supplies as well!!

Obviously we'd want to try this all out a few times before shipping crews out lightly provisioned, but it seems doable! We could cut our supplies in half, or alternatively, increase our crew by 3x, or even 5x if we left emigres there a few seasons.

The fuel is something else. The S−II stage I described earlier has 875,000 pounds of liquid oxygen liquid hydrogen. This requires 9,000 GJ of energy. The stay time on Mars might be 2.5 years if we wait a full synodic period before returning. Especially if we can 'live of the land' so to speak. This means we need a power supply of 115 kW and 400 kiloliters of water. This water is most easily extracted from the atmosphere.

With 500 W/m2 and 2 kWh/m2/da − we need 1,380 sq m of solar collectors to provide this power reliably. That's 460 of my 4ft x 8ft panels. A 'half' string of panels at 550 − fit in an 8ft x 12ft x 24ft volume and mass 11,000 lbs. Replace the water optics with mirror optics, and minimal water for cooling in the lower concentration and lower temperature mars atmosphere − further, replace the copper foil with MEMs based klystron emitters, and a simple phase delay system − and the panel delivers microwave power to a 'power tower' very very reliably − and the mass is reduced to about 2,200 lbs.

The whole setup for 60 people, aluminum coated PET film, solar panels, seeds, compressors, molecular sieves, etc, etc, etc. masses less than 22,000 lbs − and you have over 280,000 lbs ranging up to 800,000 lbs capacity!!

So, day 1 you deploy the solar panels and the PET domes along with compressors and air lines and so forth. Then, you charge up the atmosphere within the domes in two weeks − by running the compressors and whatnot at 7x the rate they're normally run to maintain oxygen and water levels. Even so, water is electrolyzed at 80% the normal rate. Then, air processing is cut back after pressure is attained − and fuel processing is increased. Still there are huge quantities of reserves in case there's a leak for examplei in one of the domes − increasing loss rates 7x above normal, or if there's a cold snap and more heat has to be generated by overpumping the air, and so forth.

It seems to me if the power requirements are so minimal, only a few watts. A kg of hydrogen contains 143 MJ of energy. Combined with 8 kg of oxygen in a fuel cell it produces 114 MJ of electrical energy. That's enough to supply 215 days worth of oxygen in a suit, along with the 8 kg of oxygen needed to burn the hydrogen. As a side benefit, you also get drinking water for the duration.

So, in a suit application, you have something very interesting without screwing around with solar panels − for early voyages before the whole living off the land is fully developed.

With a 100:1 buffer gas − you double the hydrogen consumption to build up a houseful of air and then recharge it for the same period. It seems that 5 kg of hydrogen gas burned in 40 kg of extracted oxygenshould be enough to provide Earth normal air and drinking water from the Mars atmosphere for a 2.5 year stay on Mars. .

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