Innovative Launch Vehicle for Space Exploration

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Abstract— This paper presents various techniques to improve a space vehicle by using efficient means and procedures. The procedures aim at increasing the thrust, improving take off, design and landing, and using more efficient fuel in a space vehicle for better results.

Index Terms— boosters, fusion-powered, Lift-to-drag ratio, p-B11, polypropelene,

1 Introduction

Due to the scarcity of resources and lack of foolproof safety measures space flights are becoming more costlty and rare. The Columbia disaster had shown that there is still scope for improvement in the fied of space vehicles. These various propositions in propulsion, launching, design and landing not only help in making a space vehicle cost effective but also help in making it safe for astronauts.

2 Propulsion

2.1 Exsisting technique

Spacecraft propulsion is any method used to accelerate spacecraft and artificial satellites. There are many different methods. Each method has drawbacks and advantages, and spacecraft propulsion is an active area of research. Currently spacecrafts are propelled by forcing a gas from the back/rear of the vehicle at very high speed through a supersonic de Laval nozzle. This sort of engine is called a rocket engine.

All current spacecraft use chemical rockets (bipropellant or solid-fuel) for launch, though some (such as the Pegasus rocket and Spaceship One) have used air- breathing engines on their first stage. Most satellites have simple reliable chemical thrusters (often monopropellant rockets) or resist jet rockets for orbital station-keeping and some use momentum wheels for attitude control. Interplanetary vehicles mostly use chemical rockets as well, although a few have used ion thrusters and Hall Effect thrusters (two different types of electric propulsion) to great success.

2.2 Proposed Technique

We can use fusion fuels which burn a mix of deuterium and tritium .The reaction produces most of its energy from neutron emissions, which tend to limit life of reactor and render the whole structure radioactive. It also leads to environmental problems of burning fossil fuels. It is the fusion fuel you usually hear about because it is, the easiest reaction to produce, and it is the only fuel system with any chance at all of making net power from tokamaks, laser fusion.

We can use the p-B11 fusion fuel. It requires a temperature of nearly 6 billion degrees to burn in a system operating on Maxwellian heat which is vastly higher than for burning a mix of deuterium and tritium .this can be seen by taking a look at its reaction cross-section versus initiating energy graphs, but it is remarkably clean.

The Reaction:-

The reaction results in three alpha particles which when recombined with electrons again form Helium. The waste products of this reaction are not toxic and can be breathed without any significant side effects in humans and any creatures. The reaction produces almost no neutrons. Whereas natural boron is 80% B11, it is abundant and somewhat toxic. This reaction turns a toxin into an inert gas. It releases a large amount of energy. Alpha particles have a charge of +2. The first particle carries 43% of the reaction energy, and comes off (is ejected) at 3.76Mev. The other two alphas come off (are ejected) at 2.46 million electron volts each. If you wanted to make an alpha with 3.76 MeV of energy, you will have to eject both electrons a helium atom, and accelerate it with an electric field of 3.76/2 = 1.88 million volts. To get that energy back, simply decelerate that alpha particle against a 1.88 million volt field, let it gently touch a metal plate as it comes to a stop, and it will produce two electrons of current at that voltage. This has been done on a small scale using radioisotopes. All of the energy from this reaction comes off as alphas, and since their energies are relatively close together, it should be possible to devise a method of doing the same thing with the products of the p-B11 reaction. Setting the decelerating potential at 2.46/2 = 1.23 million volts, would presumably recover 85% of the energy. Any nuclear reactor that generates its power as heat will wind up running steam turbines that waste 2/3 of the energy, this tech-

nology is quite useful. The environmental benefit of avoiding all that waste heat, the economic benefits of avoiding large cooling towers and implications for lightweight space propulsion systems all make this efficiency highly desirable. It is the greenest technology after photosynthesis. The big question?
Can electrodynamic fusion reactor burn boron? The answer surprisingly is yes. Boron has five electrons. Remove them all and the nucleus has a charge of +5. That means an electrostatic or electrodynamic acceleration system will work 5 times as hard on that nucleus as it would on a proton of charge +1.
The net result is that one only needs a potential well depth something like 100-150 kilovolts. So we can try to build a larger machine and run it at higher voltage. The world needs a technology that is compatible with existing power grids, affordable, compact, non-polluting, incapable of making nuclear weapons, and able to be used world-wide. If p-B11 fusion can be made to work; one can expect to see fusion-powered spacecraft.

3 LAUNCH

3.1 Exsisting technique

The space shuttle is launched in a vertical position, with thrust provided by two solid rocket boosters, called the first stage, and three space shuttle main engines, called the second stage. At liftoff, both the boosters and the main engines are operating. The three main engines together provide almost 1.2 million pounds of thrust and the two solid rocket boosters provide a total of 6,600,000 pounds of thrust. The total thrust at launch is about 7.8 million pounds. To achieve orbit, the shuttle must accelerate from zero to a speed of almost 28,968 kilometres per hour (18,000 miles per hour), a speed nine times as fast as the average rifle bullet. To travel that fast, it must reach an altitude above most of Earth's atmosphere so that friction with the air will not slow it down or overheat it. The journey starts relatively slowly: at liftoff, the shuttle weighs more than 2.04 million kilograms (4.5 million pounds) and it takes eight seconds for the engines and boosters to accelerate the ship to 161 kilometres per hour (100 mph.) But by the time the first minute has passed, the shuttle is travelling more than 1,609 kilometres per hour (1,000 mph) and it has already consumed more than one and a half million pounds of fuel by then.

3.2 Proposed Technique

The two boosters can be replaced by 4 boosters, two on either side since we have already discussed above a clean fuel that can be used which can provide a thrust of 13200000 pounds and will reduce the time needed for shuttle to accelerate. We can use a particle accelerator like a cyclotron which can accelerate the ejected electrons from the helium atom and thus can help in producing large amounts of energy which provide greater acceleration.

3.3 First Stage Ascent

3.3 a Exsisting Technique

After about two minutes, when the shuttle is about 45 kilometres (28 miles) high and travelling more than 4,828 kilometres per hour (3,000 mph), the propellant in the two boosters is exhausted and the booster casings are jettisoned. They parachute into some water body. These empty boosters are recovered to be eventually refilled with fuel and launched again. The solid fuel used by the boosters is actually powdered aluminium with oxygen provided by a chemical called ammonium perchlorate.

3.3 b Proposed Technique

1. The External Tanks are carried to orbit on each shuttle flight, then destroyed when force back down in the atmosphere when its odourless fuel is gone. We can keep them attached all the way into orbit and use these tanks for space station building blocks.

2. The boosters can be made up of high sunlight absorbing glass which can reduce the amount of cost required for fuels in providing thrusts.

3. This will also ensure that the boosters are not jettisoned after 2.26minutes of the launch since they can absorb energy even after that and still help in providing thrust.

3.4 Second Stage Ascent

3.4 a Exsisting Technique

The three space shuttle main engines, attached to the rear of the shuttle orbiter, continue to fire until about 8.5 minutes after liftoff, burning a half-million gallons of liquid propellant from the large, orange external fuel tank as the shuttle accelerates. The main engines burn liquid hydrogen — the second coldest liquid on Earth at minus 252.7 degrees Celsius (minus 423 degrees Fahrenheit) — and liquid oxygen. Since the hydrogen and oxygen can reach a temperature as high as 3,315.6 degrees Celsius (6,000 degrees Fahrenheit) as they burn — higher than the boiling point of iron — the engines operate at greater temperature extremes than any other piece of machinery ever built. The engines' exhaust is primarily water vapour as the hydrogen and oxygen combine. Their turbines spin almost 13 times as fast as an automobile engine spins when it is running at highway speed. Eight and a half minutes after launch, with the shuttle travelling 8 kilometres (5 miles) a second, the engines shut down as they use the last of their fuel. A few seconds after the engines stop, the external fuel tank is jettisoned from the shuttle. The only part of the shuttle that is not reused, the tank re-enters the atmosphere and burns up over the Pacific Ocean. The shuttle orbiter, the only space shuttle component that will circle the Earth, weighs only about 117,934 kilograms (260,000 pounds). The shuttle has consumed more than 1.59 million kilograms (3.5 million pounds) of fuel during its first 8 ½ minutes of flight.

3.4 b Proposed Technique

1. A cooling and electrolysis system can be installed in the main engine which can convert the water vapour obtained as the by-product by the burning of fuel into oxygen and hydrogen which can again be used as fuel in the main engine.

2. The above system should be made such that it can be operated manually, so when the astronauts feel they need an extra thrust or running out of fuel they can switch on this system. This way less amount of fuel will be used as the same fuel can be reused again and again.

3. By using this system the space vehicle will no longer be using orbits thus reducing its weight considerably. Since the boosters and main engines now can provide enough fuel to circularize the shuttle's orbit at a safe altitude to keep it above the atmosphere. (After the main engines shut down, the shuttle is in an egg-shaped orbit that, if nothing changed, would cause it to re-enter the earth's atmosphere. But, about 35 minutes after the main engines have shut down, usually when the shuttle has reached the highest point of the egg-shaped orbit, the two orbital manoeuvring system engines, located on the left and right side of the shuttle's tail, are fired for about three minutes. The orbital manoeuvring system engines use two propellants that automatically burn whenever they contact one another and the three-minute firing circularizes the shuttle's orbit at a safe altitude).

Reducing the cost

Most of the launch cost is due to weight and the fuel required for launching the vehicle to the proper orbit. If additional thrust could be created once in space, less fuel would be required, thereby also reducing weight factors.

What new can be done?

The boosters can be made up of glasses which can absorb large amounts of sunlight inside which an energy absorbing system can be kept. The absorber can then be cooled by heating hydrogen gas circulating through it. The hydrogen which in turn becomes hot can be expanded through a nozzle to provide very high thrust.

4 DESIGN

Various designs have been proposed about space vehicles.
What I propose is a design where:

1. The Lift-to-drag ratio or L/D close to 7 or slightly less. A lift to drag ratio of 7 means that a thrust force equal to 1/7th of the weight of the aircraft is sufficient to support it in flight. This low thrust requirement significantly reduces the amount of fuel required to carry the weight of an aerospace plane in comparison to rocket launch systems which must provide thrust greater than the weight of the vehicle.
2. A wingless launch vehicle has lower aerodynamic forces affecting the vehicle. Some fins are attached to aid stability. For a winged vehicle the centre of lift moves during the atmospheric flight as well as the centre of mass and the vehicle spends longer in the atmosphere as well. Thus a modern space vehicle should have a wide wingspan to provide extra stability and the wings should have minimal thickness. The wings should be as light as possible.
3. The engines should preferably be at the front end rather than the rear one and should be as light in weight as possible as having a heavy engine at the rear end puts a heavy mass at the rear of the aircraft with wings that had to hold up the vehicle. As the wet mass reduces, the centre of mass tends to move rearward behind the centre of lift, which tends to be around the centre of the wings. This can cause severe instability which is usually solved by wings but they also add weight and decrease performance.
4. A vertically-launched rocket forms the shape of a cylinder stood on end. This structure can be made very light and strong. A horizontally-launched space vehicle approximates a cylinder on its side. This structure experiences greater bending forces, so must be strengthened. This makes it heavier.
5. To reduce its weight one can attach the fuel tank directly to the space vehicle thus saving the weight of fasteners while also stiffening both parts.
6. One can create a space vehicle with a material like polypropelene which is currently used to cover ice sheets in Greenland and can withstand very high and low temperature.

5 LANDING

5.1 Exsisting technique

When it is time to return to Earth, the shuttle is rotated tailfirst into the direction of travel to prepare for another firing of the orbital maneuvering system engines, a firing called the deorbit burn. This three minutes long engine firing slows the shuttle and it begins to descend toward the atmosphere.The three-minute firing is the only active brake the shuttle will use as it heads toward a landing. The rest of its descent is devoted to slowing down using only the drag produced by the atmosphere. After the firing takes place, it is about another 25 minutes before the shuttle will descend to a point that it first en-

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counters the effects of the atmosphere. Before it reaches the upper atmosphere, the shuttle is oriented with the nose angled up about 40 degrees from horizontal and its wings level, an orientation that keeps the black thermal tiles on the underside facing the majority of the heat generated by its encounter, heat that can range as high as 1,648.9 degrees Celsius the leading edges of the wings and nose. The aft steering jets are used to control the shuttle's orientation as it descends into the atmosphere. As it descends, however, it begins a transition from spacecraft to aircraft, and its aero surfaces -- the wing flaps and rudder -- gradually become active as air pressure builds. As those surfaces become usable, the steering jets turn off automatically. During its descent, the shuttle performs a series of four steep banks, rolling over as much as 80 degrees to one side or the other, to slow down. The series of banks gives the shuttle's ground track toward landing an appearance similar to a highly elongated letter "S".

As the shuttle continues toward landing and its speed drops to less than three times the speed of sound, or Mach 3, two air data probes are deployed from either side of the nose of the spacecraft. These probes provide supplemental information on the airspeed and altitude derived from the outside barometric pressure and wind speed.
As it aligns with the runway, the shuttle then begins a steep descent with the nose angled as much as 19 degrees down from horizontal. At this point; the pilot deploys the landing gear. As the shuttle's main landing gear touches down, it is dropping at less than 8 kilometres per hour (5 miles per hour) and has a forward speed of about 354 kilometres per hour (220 miles per hour). After touchdown, the pilot deploys a drag chute from a compartment located just below the tail and the commander begins to drop the shuttle's nose gear slowly toward the runway. The drag chute is then jettisoned before the wheels come to a stop to ensure that it falls clear of the shuttle.

5.2 Proposed Technique

The fuel present in the space vehicle can be reignited and made to burn at times, during descend. When the vehicle enters the earth’s atmosphere it should be made to rotate several times and the burning of fuel should be used to align itself quickly .This will reduce the time taken for its landing.

Also the vehicle can be coated with a coolant so that when it is re-entering earth’s atmosphere it does not catch fire due to overheating. These are some of the new steps that can be taken to ensure safe and fast landing of space vehicles.

6 CONCLUSION

This study shows that more efficient and non polluting fuels can be used to reduce the cost of a space vehicle. Its ascent, descent and landing could be made safer by trying to implement one the the aforementioned techniques. This could make traveling to space safer for astronauts and more cost effective for organizations

7 REFERENCES

WIKIPEDIA