Uranium−239 Radioisotope Rockets

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Uranium 239 has a half life of just over 20 minutes. It is routinely created with existing technology, but it has never to my knowledge been separated out within 20 minutes of being created. Instead it decays to Plutonium which can then be fissioned for energy.

I propose to build 3,000 nuclear reactors that use liquid deuterium as both a moderator and coolant similar to the kiwi rocket reactor which ran at 4 GW. It is possible for such a reactor, in principle, to create 1 kg of Uranium 239 within 20 minutes. Given 3,000 such reactors (and say each one costs just $1 million to build and then some to operate) it is possible for around $3 billion to create 3,000 kg of Uranium 239. I call the idea "flash−nukes" because it flashes out the Uranium−239 radioisotope.

3,000 kg of half−decayed U−239 will have a power output of over 222 GW and with nine giant turbopumps, each with 10 times the pumping capacity as the liquid hydrogen turbopumps in the space shuttle, it is possible for a 1,750,000 kg rocket to accelerate from the surface of Earth at 3 g's until it runs out of fuel. Assuming a specific impulse of just twice the space shuttle main engines, which is very reasonable, we can easily send a 10% usable payload (175,000 kg second−stage) on a trajectory towards Mars.

Using six such rockets it is possible to do a manned two−way mission to Mars with 7 people. Three are needed to land an Earth Return Vehicle and associated support equipment including a nuclear reactor and equipment to mine Mars water ice and turn it into liquid hydrogen and oxygen for propulsion for the trip back to Earth. One is a habitat with supplies for 3+ years (we use dried food, locally mined water is used). One is the crewed vehicle from Earth, and doubles as the Mars base (to be buried with dirt for radiation protection).

The sixth rocket to Mars is sent last, when the crew is ready to return. It's a Mars Return Vehicle, which the Mars Ascent Vehicle boosts up to and docks with; the crew is transfered and then the MRV returns to Eath (it's fueled up with propellant from Earth).

Now a radioisotope rocket is NOT a crazy idea. It's real, it's been done before. It eliminates the need for a fission reactor which needs radiation shielding to shield the crew from the neutrons. It may have radioactive exhaust. A radioisotope rocket has no fissioning, no neutrons, and no radioactive exhaust. It just works, it's relatively easy too!

Can anyone out there help me calculate the cost of performing six missions every three years, so that just when a crew wants to leave they are "relieved" by a new crew? I assume it would cost only 1.5 billion plus another billion US dollars for unrelated infrastructure.

Now if we look at the cost of the U−239, assuming we run 3,000 x 4 GW nuclear reactors for 20 minutes, that's 1.44e16 J. At 5 cents/kWhr that works out to a cost of just 200 million dollars.

Now the rocket has a mass of 1,750,000 kg.
I know it takes energy to produce liquid hydrogen but suppose the rocket costs $200 per kg on average. I have no idea what it would be made from, but $200 per kg sounds pretty reasonable to me − at least form a physics stanpoint. Some specialty parts might be needed, but how low can it go in principle?

200 million dollars plus $200 / kg * 1,750,000 kg equals 350,000,000 dollars. Thus I assume each rocket will cost 750,000,000 dollars. We launch on average (or at least pay for) 2 per year. Hence I expect a 1.5 billion dollar budget gets you to Mars with an additional 1 billion for infrastructure costs (such as people's salaries).

Can anyone out there provide some hints about this idea − has it been done before, why not, is it feasible? Maybe I am off by an oder of magnitude in cost estimation. If so, a manned mission to Mars would cost 15 billion dollars. This is in line with what using an Ares I and several Ares V rockets would cost to get to Mars.

The idea is to have filaments of U−239 (3,000 x 1kg filaments) in a ten huge "combustion chambers", each with 300 kg of U−239. Liquid hydrogen is pumped in, it boils and is exhausted at twice the specific impulse of the space shuttle main engine. This allows for great performance.

How to make the U−239? I propose a deuterium nuclear reactor with natural uranium. It's a flash−nuke, running way beyond melt−down at a 4 GW like the kiwi nuclear rocket reactor. The deuterium will allow U−235 to fission without enrichment being necessary. All those neutrons will transform U−238 into U−239. 1 kg of U−239 can be made in 20 minutes in theory, but I don't know how to do it in practice. Anyone have any ideas?

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One issue is, you have to separate the second stage from the first stage somehow because the first stage is going to melt down when it runs out of liquid hydrogen coolant. My target was for only 13,500 m/s delta−V, enough to go from the surface of Earth to a Mars trajectory. At 3g's acceleration, this takes 7.65 minutes. So we have enough hydrogen for 8 minutes or so, then we separate and the first stage does a nuclear melt−down! Does that bother you?

Another issue is I propose to launch from Antarctica. It's a legal nightmare. Where do you think I could launch from in principle if it were possible? Any countries out there that would want a nuclear rocket?

Finally there is cost. How to get a 2.5 billion dollar budget, increasing with inflation each year? That is the real show stopper here. I was thinking only a new technology could generate revenues that high, preferably an energy technology. 2.5 billion dollars a year is equivalent, at 2 cents/kWhr profit, to 15 GW. If you had a 15 GW plant of some sort, you could in principle sell energy and if you divert 2 cents/kWhr to the space project, you could pay for it.

We really need a new energy technology and a lot of investors. Solar power is my favorite, especially solar power troughs. One can calculate the cost of thin aluminum reflectors (mirrors) and if that's all a solar power trough was, we'd be in business! Unfortunately we need to transfer the heat to a fluid which then boils water and turns a turbine, all that adds to the cost. In principle is it possible to get the budget we need? Say we had 25 billion dollars to invest, then could we start colonizing Mars? Lets see how far fetched this is with a calculation.

To get 15 GW, we need a surface area (assuming 25W/m^2 on average) of 25 km x 25 km. That's a lot of aluminum and remember aluminum is not all a solar power trough is made out of! But just for a lower limit estimate, can you do it with 25 billion dollars? If we sell the energy for 5 cents/kWhr, we can spend 1 cent on maintainence, 2 cents go to the investors, and 2 cents to the space project.

25e3*25e3 m^2 is the surface area of our solar power project. In principle, suppose the reflectors are 5000 kg/m^3 and 0.001 m thick. Then we have a mass of 3,125,000,000 kg just for the reflectors (this assumes it's flat and not parabolic, hence it's a real lower limit).
In order to afford the project with a $25 billion budget, we need our solar power project to cost just $8 / kg. This is not outside the realm of possibility, it's just a little far fetched by today's standards.

I really think solar power can pay for Mars colonization.
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