Re: The Dual−stage 4−grid Ion Thruster

Source: http://sci.tech−archive.net/Archive/sci.space.history/2005−12/msg00949.html

- *From*: "klreed" <klreed@xxxxxxxxxxxxx>
- *Date*: 27 Dec 2005 18:23:48 −0800

Hi,
How about if the solar arrays were made of our new CP1/a−Si:H
Ultra−lightweight solar cells at a power density of 4300 W/kg? Do you
think a 24 kilogram, 814 m², 100 kW space solar array could solve some
of the energy requirement problems for the DS4G?
klreed

meiza wrote:
> Rémy MERCIER <Rmy.MERCIER.1zqsxn@xxxxxxxxxxxxxxx> wrote:
>
> > This is a new esa' ion thruster, THE 'DS4G' THRUSTER,
> > with isp = 19200s
> > nice!
> > http://www.esa.int/gsp/ACT/propulsion/safe_test_diaries_wk1.htm
>
> Huh, quite a great isp, but where do you need such a thing?
>
> If a vehicle had just one third of it's mass fuel,
> this engine could accelerate it to 80 km/s! (In space of
> course, and it would take a lot of time.)
> A cheat sheet* tells the trip to Mars from LEO needs less
> than 5 km/s.
>
> But the power consumption must be big compared to thrust and
> total impulse too. The higher the exhaust velocity, the more
> energy you actually give to the expelled fuel instead of the
> vehicle. So the crafts with these motors would need to have
> either big solar cells (makes them heavy, reduces mass
> fraction and acceleration), or then really low thrust
> requirements (i.e. these would be used on stationkeeping).
>
> Has someone calculated optimal isp:s for certain trips
> and ion engines / hall thrusters?
>
> Thrust is proportional to exhaust velocity but power
> is proportional to exhaust velocity squared.
> There's no point in having a huge isp craft
> if it reaches it's good velocity only after 10
> years of thrusting, when the other one with

> worse isp would already be at the destination.
>
>
> I guess it boils down to the rocket equation.
> Deltav is proportional to both exhaust velocity
> and the logarithm of mass ratio.
>
> With low mass ratios (only a bit above 1), the
> derivative of the logarithm is close to 1, and
> it's easier to grow that than isp.
> Acceleration drops then with increasing fuel mass.
>
> If instead isp (v_ex) was grown, and the thrust
> kept at constant, the power would grow to the
> power of two − the solar arrays balloon faster
> than the fuel tank. So acceleration would
> drop faster.
>
> Only at high mass ratios does the logarithmic
> behaviour begin to show and you hit diminishing
> returns. Only then it's wiser to increase isp.
>
> But with this high isp (20 000) and for example a
> mass ratio of 2.7 (1 part rocket, 1.7 part fuel),
> you'd get the 200 km/s delta v. Where do you need
> that?
> And how long would even a no−payload thingy
> take to accelerate to that speed?
>
> I guess for a trip to Jupiter or further you'd need
> nuclear energy, which isn't very power−dense, so you're
> better off just having a worse isp and more fuel. (I'd
> guess this gives smaller total mass at same triptime.)
>
> Not even trips to asteroids or comets and back, all close
> to Sun...
>
> So the main problem with ion engines to me seems to be
> *too high* isp!
>
> *) handy "cheat sheet":
> http://www.pma.caltech.edu/~chirata/deltav.html

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- ***Follow−Ups***:
  - ***Re: The Dual−stage 4−grid Ion Thruster***
    - ◊ *From:* Rémy MERCIER

- ***References***:
  - ***The Dual−stage 4−grid Ion Thruster***
    - *From:* Rémy MERCIER
  - ***Re: The Dual−stage 4−grid Ion Thruster***
    - *From:* meiza

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