

Using EML2 Refueling For Mars Lander

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1 Preliminary Analysis

The ΔV budget for Earth to Mars and Earth to EML2 to Mars is comparable. This fact along with the stability of EML2 allows for possible refueling from Earth to Mars.

doesn't account for it) and that there is only one stage:

$$T_F = \frac{e^{\frac{\Delta V}{V_e}} (R_{F_2}(1 + R_{d:F} + c) - R_{F_2}(1 + R_{d:F}) - c)}{1 + T_{d:F} - e^{\frac{\Delta V}{V_e}} \times T_{d:F}}$$

1.1 Mars Rocket Propellant Tanks

Using common estimates for ΔV from LEO to EML2 and EML2 to Mars, the difference is only about 0.1 km s^{-1} out of 3.4 km s^{-1} for LEO to EML2 and 3.3 km s^{-1} for EML2 to Low Mars Orbit. This similarity will allow for the same propellant tank to be used for both Earth to EML2 and EML2 to Mars without inefficiencies from additional weight from oversized propellant tanks. Additionally, it is preferable for LEO to EML2 to require more fuel than more fuel for EML2 to Mars so that the ascent stage won't have to carry more weight and space.

- T_F : Tanker Fuel.
- ΔV : Velocity budget required to get to EML-2 from initial point .
- V_e : Exhaust Velocity.
- R_{F_2} : Fuel Required for Mars Rocket.
- $R_{d:F}$: The ratio between drymass of propellant tanks and fuel for R .
- c : Invariant mass of the Tanker.
- $T_{d:F}$: The ratio between drymass of propellant tanks and fuel for T to get to EML2.

2 Equations

In this section, we present three equations related to our research.

2.1 Equation 1: Taker Initial \rightarrow EML2 Fuel Calculation

The first equation calculates the value of T_F based on Mars Rocket (R) parameters. It assumes that the tanker is out of atmospheric effects (as this

2.2 Equation 2: EML2 \rightarrow Mars Fuel (R_{F_2}) Calculation

The second equation defines the amount of fuel needed for Mars Rocket to get to Mars from EML2. Entry, Descent, and Landing should not be factored in here. Rather, that should be the craft within the payload section of this equation:

$$R_{F_2} = \frac{pe^{\frac{\Delta V}{V_e}} - p}{1 + R_{d:F} - R_{d:F} \times e^{\frac{\Delta V}{V_e}}}$$

- R_{F_2} : Fuel needed to get to Mars from EML2.
- ΔV : Velocity budget required to get to Mars from EML-2.

- V_e : Exhaust Velocity.
- p : Payload.
- $R_{d:F}$: The ratio between the dry mass of the propellant tanks and fuel within.

2.3 Equation 2: Mars Rocket Initial → EML2 Fuel Calculation

The third equation defines the amount of fuel for Mars Rocket (R) to get to EML2 from its initial point. This assumes initial point is out of atmospheric effects (as this doesn't account for it) and only has one stage that it shares with EML2 → Mars.

$$R_{F_1} > R_{F_2} \implies R_{F_1} = \frac{ce^{\frac{\Delta V}{V_e}} - c}{1 + R_{d:F} - R_{d:F} \times e^{\frac{\Delta V}{V_e}}}$$

$$R_{F_1} < R_{F_2} \implies R_{F_1} = e^{\frac{\Delta V}{V_e}} (R_{d:F} R_{F_2} + c) - a R_{F_2} - c$$

- R_{F_1} : Mars Rocket Fuel to get to EML2 from initial point.
- R_{F_2} : Mars Rocket Fuel to get to Mars from EML2.
- ΔV : Velocity budget required to get to EML-2 from initial point
- V_e : Exhaust Velocity.
- $R_{d:F}$: The ratio between drymass of propellant tanks and fuel for R .
- c : Invariant mass of the Mars Rocket.