Raymer Manned Mars Plane - analysis by Joabe Marcos de Souza

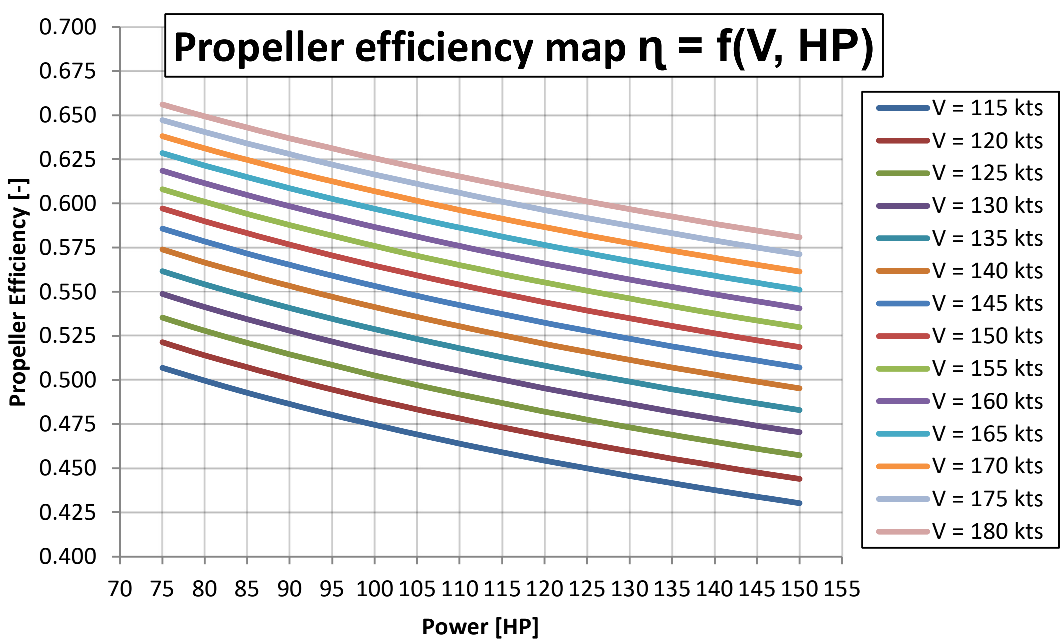
Mars atmosphere was modeled according to equation bellow, as presented by NASA (https://www.grc.nasa.gov/WWW/K-12/airplane/atmosmrm.html#:~:text=Mars%20Atmosphere%20Model%20%2D%20Metric%20Units&text=The%20Martian%20atmosphere%20is%20an,to%20the%20edge%20of%20space.&text=Thus%2C%20the%20gas%20temperature%20is,decreases%20as%20we%20increase%20altitude.).

$$For\ h > 7000: \begin{cases} T = -23.4 - 0.00222 * h \\ p = 0.699 * e^{-0.00009*h} \\ \rho = \dfrac{p}{(0.1921 * (T + 273.1))} \end{cases}$$

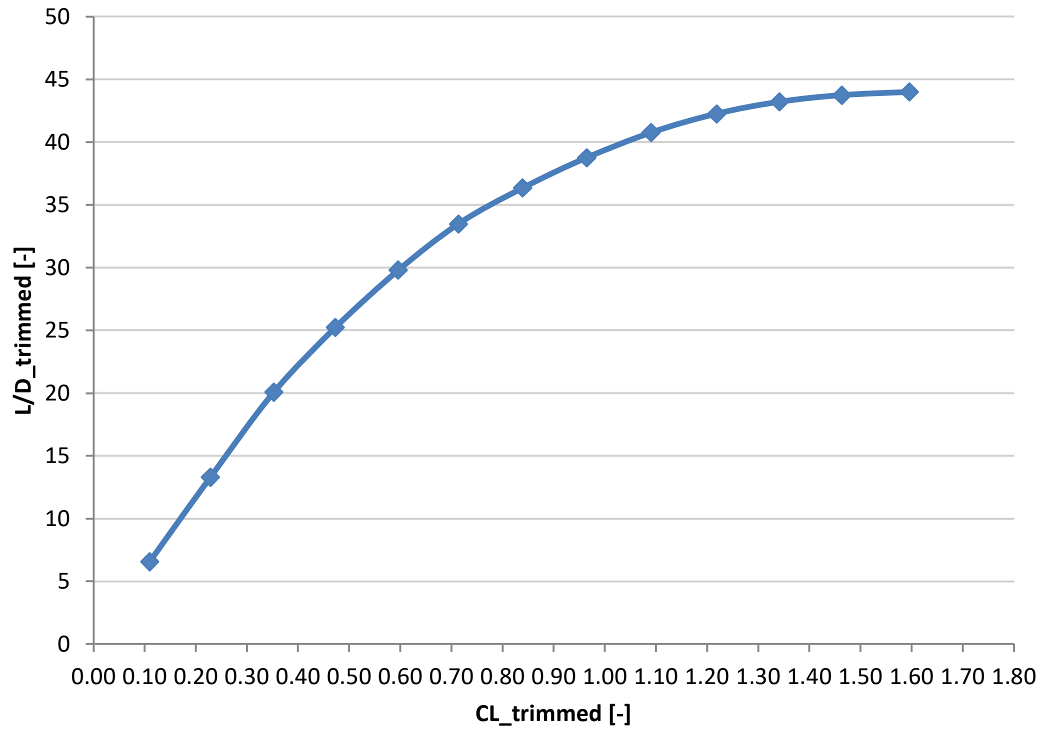
$$For\ h < 7000: \begin{cases} T = -31 - 0.000998 * h \\ p = 0.699 * e^{-0.00009*h} \\ \rho = \dfrac{p}{(0.1921 * (T + 273.1))} \end{cases}$$

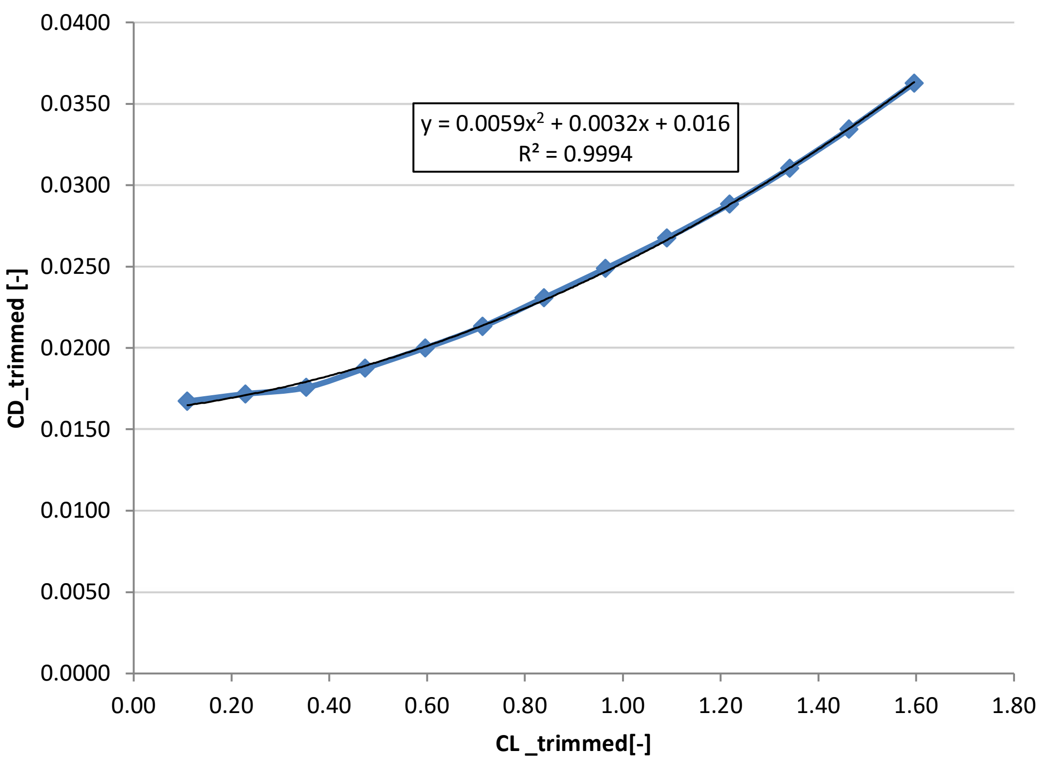
Where: ρ = density (kg/m³)
p = pressure (Pa)
T = temperature (ºC)
h = altitude (m)

Using the Mars density and aircraft data it was possible to plot the propeller efficiency map, using Momentum Theory, in order calculate the aircraft performance in climb and cruise phases.



The aircraft trimmed data was estimated in order to obtain aerodynamic data as L/D and drag polar.





Considering the ratio of battery weight to takeoff gross weight (m_b/m_{TO}) equals to 0.13, it was obtained a range of 1238 km cruising at a speed of 150 knots. Also, a rate of climb greater than 3000 fpm was obtained for all operational speeds. It was considered a value of 90% for the total efficiency of the electric propulsion system (η_e), and integration efficiency (η_{INT}) of 97%

due installation losses. It is important to state that the battery specific energy of 500 Wh/kg is used considering a timeframe of 2030-2035.