Thrust vs. Weight

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Program: Thrust_Weight_Calculation

Semester: Fall 2025

SAE Aero Regular Class

Note: Calculation analyzes the thrust based on motor (https://innov8tivedesigns.com/badass-2315-1480kv-brushless-motor.html?srsltid=AfmBOooTF9tN5kyCK5YNS0f4XBU2nfc2le8CH_L0wDMY7lEFeJl3XEEp). A coefficient of thrust of 0.3 was used, based on an approximation of three blade propellors.

```
% Set-up
clear;
close all;
clc;

% Inputs
kt = 0.3;              % Coefficient of thrust (dimensionless)
rho = 1.204;            % Air density in San Antonio Texas at 20 °C [kg/m^3]
V = 1:.1:14.8;          % Motor power Supply [V]
D_inch_2 = 12;          % Propeller diameter for two prop [in]
D_inch_4 = 9;           % Propeller diameter for four prop [in]
W_e = 20.5:.25:55;      % Weight [lbs]

% Calcs
RPM_2 = V.*470;           % Motor rated V -> RPM, per a 12x6-E propellor
RPM_4 = V.*545;           % Motor rated V -> RPM, per a 9x7x3 propellor

% Convert units
n_2 = RPM_2 / 60;                     % Propellor speed for two propellors [rev/sec]
n_4 = RPM_4 / 60;                     % Propellor speed for four propellors [rev/sec]
D_2 = D_inch_2 * 0.0254;              % inches -> [m]eters
D_4 = D_inch_4 * 0.0254;              % inches -> [m]eters
W = W_e*4.4482216153;                 % Weight [N]
```

Link to the motor ratings per propellor diameters: https://innov8tivedesigns.com/pub/propcharts/BA2315-1480-Specs.htm

$$T = k_T \rho n^2 D^4,$$

In the above equation, T stands for Thrust in Newtons, kt is the thrust coefficient which is dimensionless, rho is density of the fluid in kg/m^3, n is propellor speed in rpm, D is the propellor diameter in m.

```
% Thrust calculation
T_2 = 2.*(kt.*rho.*n_2.^2.*D_2.^4);             % [N] Thrust of Two prop plane
T_4 = 4.*(kt.*rho.*n_4.^2.*D_4.^4);             % [N] Thrust of Four prop plane
Tmax_2= max(T_2);                               % [N] Max Thrust of Two prop plane
Tmax_4= max(T_4);                               % [N] Max Thrust of Four prop plane
Tmax_2v = ones(size(W)) * Tmax_2;               % [N] Max Thrust converted to vector
Tmax_4v = ones(size(W)) * Tmax_4;               % [N] Max Thrust converted to vector

% Thrust vs Weight Ratio Min.
T_W2 = Tmax_2v./W;                              % Max thrust/weight of two propellors, dimensionless
T_W4 = Tmax_4v./W;                              % Max thrust/weight of four propellors, dimensionless

% Display result
fprintf('Thrust max for two propellors = %.2f N\n', Tmax_2);
```

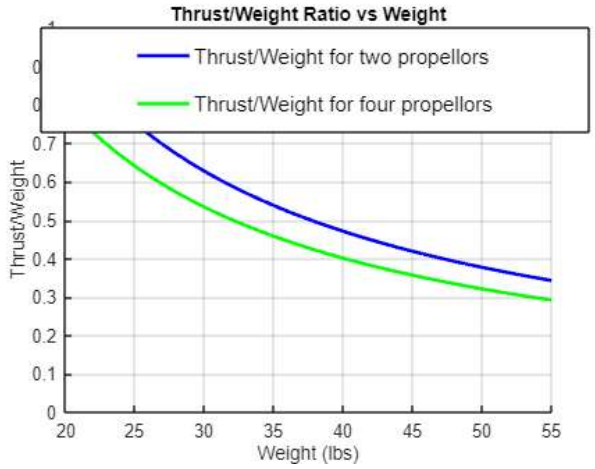
```
Thrust max for two propellors = 83.80 N
```

```
fprintf('Thrust max for four propellors = %.2f N\n', Tmax_4);
```

```
Thrust max for four propellors = 71.31 N
```

```
figure;
hold on
plot(W_e,T_W2, 'b-', 'LineWidth', 2)
plot(W_e,T_W4, 'g-', 'LineWidth', 2)
ylim([0 1]);
```

```
xlim([20 max(W_e)]);
xlabel('Weight (lbs)');
ylabel('Thrust/Weight');
lgd1 = legend('Thrust/Weight for two propellors','Thrust/Weight for four propellors',"Position", [0.15349,0.72092,0.75019,0.19065]);
lgd1.FontSize = 12;
title('Thrust/Weight Ratio vs Weight')
grid on
hold off
```




```
figure;
hold on
plot(V,T_2, 'b-', 'LineWidth', 2)
plot(V,T_4, 'g-', 'LineWidth', 2)
ylim([0 Tmax_2]);
xlim([0 max(V)]);
xlabel('Voltage (V)');
ylabel('Thrust (N)');
lgd2 = legend('Thrust for two propellors','Thrust for four propellors',"Position", [0.18928,0.73643,0.44853,0.13872]);
lgd2.FontSize = 12;
title('Thrust vs Voltage')
grid on
hold off
```