MEE 225 Introduction to Flight
Mechanical and Aerospace Department
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**Thrust Equation**

Hey guys,

 Inorder to understand how thrust is generated from the engines, we need to look at the governing equations. I don’t like to start a topic with equations but in this case, it actually makes sense to do so. You will soon realize the reason.



Please go through the derivation as a group and make sure you understand the steps involved. Also, fill out the missing steps in the derivations.

**I. Conservation of Mass:**

|  |  |
| --- | --- |
| $$\frac{d}{dt}∭\_{}^{}ρ.dV+ = $$ |  |

The first term on LHS represents \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The second term on LHS represents \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**II. Conservation of Momentum:**

|  |  |
| --- | --- |
| $$ \frac{d}{dt}∭\_{}^{}ρV.dV+ = $$ |  |

The first term on LHS represents \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The second term on LHS represents \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

The first term on RHS represents \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The second term on RHS represents \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The third term on RHS represents \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Assuming Steady and Inviscid flow and no body force Equation 2 reduces to

|  |  |
| --- | --- |
| $$ = ∬\_{}^{}∇p. ds$$ |  |

**III. Apply Conservation of Mass to the control volume assuming steady flow**

|  |  |
| --- | --- |
| $$-ρ\_{1}A\_{1}V\_{1}+ = $$ |  |

Assuming constant density, Equation 4 simplifies to

|  |  |
| --- | --- |
| $$ =A\_{2}V\_{2}$$ |  |

**IV. Apply Conservation of Momentum to the control volume assuming 1D, steady flow, incompressible and inviscid flow with no body force**

|  |  |
| --- | --- |
| $$-ρ\_{1}A\_{1}V\_{1}^{2}+ = P\_{1}A\_{1}-P\_{2}A\_{2}+Thrust $$ |  |

Using the result from Equation 5, Equation 6 can be simplified to

|  |  |
| --- | --- |
| $$ρ\_{1}V\_{1}A\_{1}\left( \right)= P\_{1}A\_{1}-P\_{2}A\_{2}+Thrust $$ |  |

Assuming constant area, Equation 7 can be further reduced down to

|  |  |
| --- | --- |
| $$\left( \right)=\left(P\_{1}-P\_{2}\right)A+Thrust $$ |  |

Solving for thrust,

|  |  |
| --- | --- |
| $$Thrust= V\_{2} - V\_{1} - \left(P\_{1}-P\_{2}\right)A $$ |  |

Let $V\_{2}=V\_{exit}$ (Velocity at the exit of the engine) and $V\_{1}=V\_{in}$ (Velocity at the inlet of the engine)

Equation 9 can then be written as

|  |  |
| --- | --- |
| $$Thrust= V\_{exit} - - \left(P\_{inlet}-P\_{exit}\right)A $$ |  |

1. What are the terms in Equation 10 contribution to thrust?

2. What are the terms in Equation 10 inhibiting the thrust?

3. From Equation 10, what are the different ways by which you can increase the thrust from the engine?