UNIFIED PROPULSION \( P_2 \) SOLUTIONS (WATTS)

USE INTEGRAL MOMENTUM THEOREM IN VEHICLE REFERENCE FRAME.

VELOCITY OF REFERENCE FRAME = \( V \) (VELOCITY OF VEHICLE).

ALL OTHER VELOCITIES ARE RELATIVE TO \( V \) AND ARE LABELED \( \vec{u} \).

\[ \sum F_x = \frac{dV}{dt} \int_{\text{Vol}} p dV_{\text{Vol}} + \int_{\text{Vol}} \frac{d(pu_x)}{dt} dV_{\text{Vol}} + \int_S u_x (p\vec{u}) \cdot \mathbf{n} \, ds \]

\( \sum F_x \) = SUM OF EXTERNAL FORCES = 0 SINCE PROBLEM SAYS TO NEGLECT DRAG

ACCELERATION RELATIVE TO INERTIAL REF. FRAME

\( = M \frac{dV}{dt} \)

CHANGE IN MOM. OF MASS WITHIN C.V. RELATIVE TO C.V. REF. FRAME

\( = 0 \) SINCE MASS OF VEHICLE NOT CHANGING AND CAN NEGLECT ANY UNSTEADY CHANGES IN MOMENTUM OF WATER PER PROBLEM STATEMENT

C.V. MOVING WITH AIRPLANE AT \( V(t) \)

\[ 0 = M \frac{dV}{dt} + \int_S u_x (p\vec{u}) \cdot \mathbf{n} \, ds \]
b) \[-\frac{M dV}{dt} = -A j_{pj} (v_j - v)(v_j - v) - A j_{pj} (v - v)(v_j - v)\]

\(\text{flow in}\)  \(\text{flow out}\)

\(\text{OPPOSITE TO NORMAL}\)

\(\text{NEGATIVE} \ x \ - \text{DIRECTION}\)

\(\text{NOTE THE SIGNS ARE BOTH NEGATIVE BUT FOR DIFFERENT REASONS!}\)

EQUATIONS OF MOTION:

\[
\begin{align*}
\frac{dV}{dt} &= \frac{2A j_{pj}}{M} (v_j - v)^2 \quad v_j > v \\
\frac{dV}{dt} &= 0 \quad v_j < v
\end{align*}
\]

c) \[F = -2 j_{pj} A j (v_j - v)^2\]

\[T = -F = 2 j_{pj} A j (v_j - v)^2\]