The Linear Momentum Equation using an Inertial Frame of Reference



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Recall the Reynolds Transport Theorem:

$$\frac{D}{Dt} \left(\int_{\underline{V}_{S}} \beta \rho dV \right) = \frac{d}{dt} \left(\int_{CV} \beta \rho dV \right) + \int_{CS} \beta (\rho \boldsymbol{u}_{rel} \cdot d\boldsymbol{A})$$

Fon system $+ \mathbf{F}_{\text{surface on system}}$

$$\frac{D}{Dt}\left(\int_{V_{\text{system}}} \mathbf{u}_{XYZ} \rho dV\right) = \frac{d}{dt} \int_{CV} \mathbf{u}_{XYZ} \rho dV + \int_{CS} \mathbf{u}_{XYZ} \left(\rho \mathbf{u}_{\text{rel}} \cdot d\mathbf{A}\right)$$

$$\underbrace{\mathbf{F}_{\text{body on CV}}}_{\text{acting on the CV}} + \underbrace{\mathbf{F}_{\text{surface on CV}}}_{\text{acting on the CV}} = \frac{d}{dt} \int_{CV} \mathbf{u}_{XYZ} \rho \, dV + \underbrace{\int_{CS} \mathbf{u}_{XYZ} \left(\rho \mathbf{u}_{\text{rel}} \cdot d\mathbf{A}\right)}_{\text{ret act and the CV}}$$