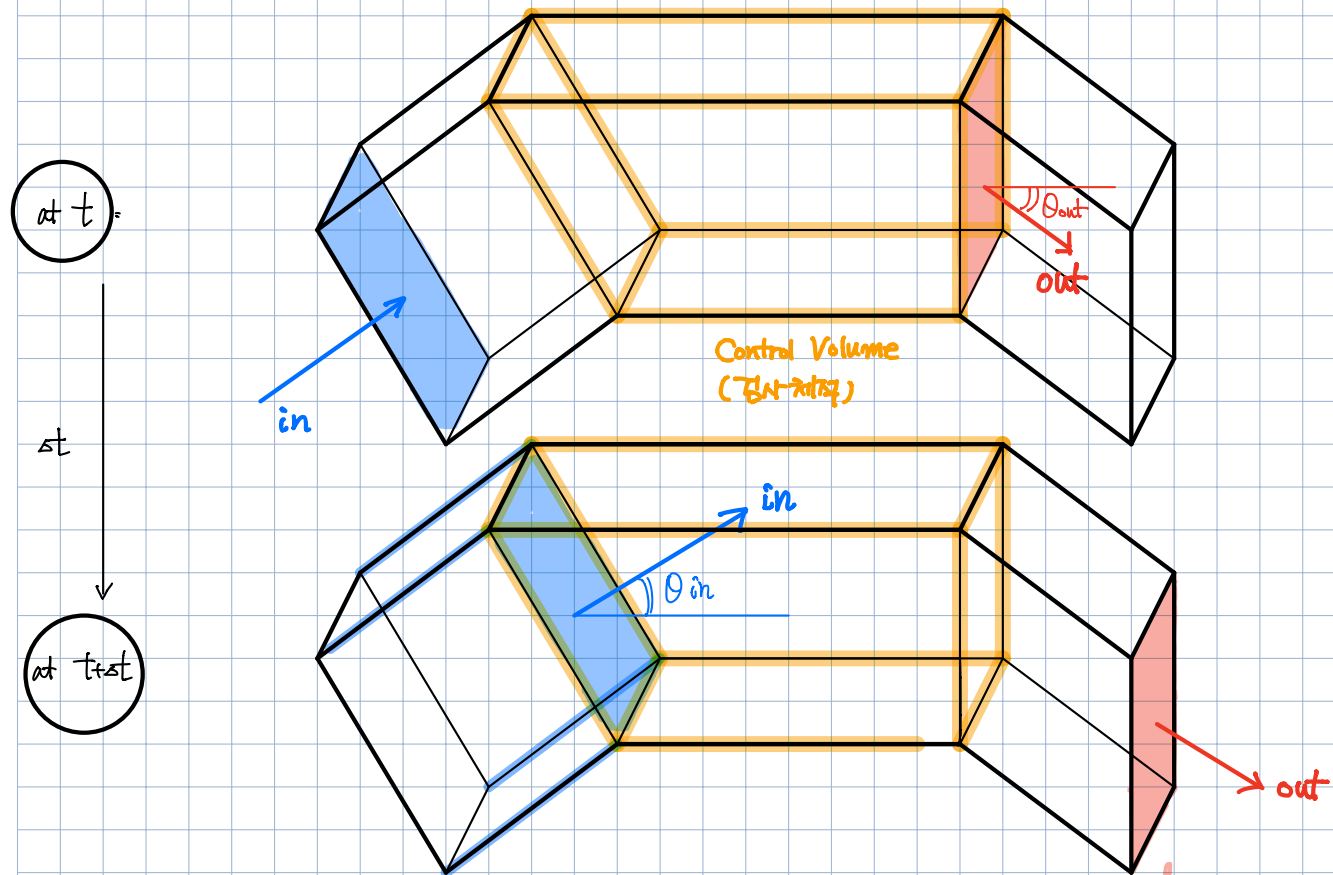
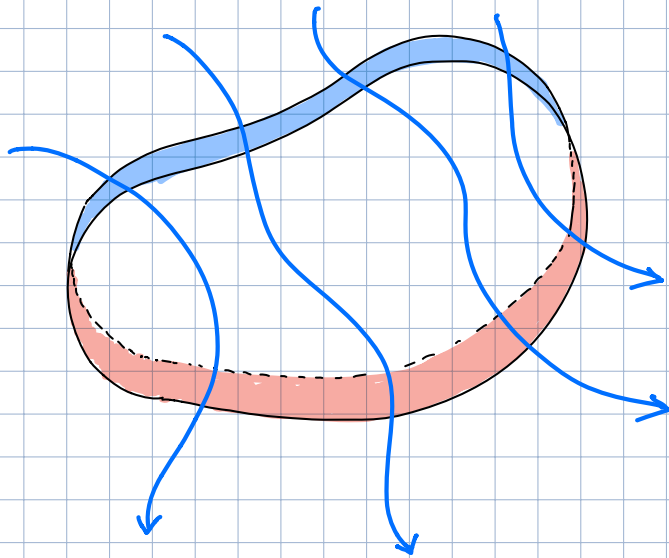


Reynolds Transport Theorem



유입된 부피: $dV_{in} = v_{in} \cdot dA_{in} \cdot dt \cdot \cos \theta_{in}$

유출된 부피: $dV_{out} = v_{out} \cdot dA_{out} \cdot dt \cdot \cos \theta_{out}$

$V(t) = A \times l = A \times (v \times t) \leftarrow v = \frac{dV}{dt}$
 $= vAt$

B: any property

$$B_{\text{tot}} = \int_V \beta dm \leftarrow \beta = B/m, \quad dm = \rho dV \quad (\rho = m/V)$$

$$= \int_V \beta \rho dV$$

$$m = \rho V$$

$$dm = d(\rho V) = \frac{d\rho}{dt} V + \rho dV$$

CV인 경우 B의 (시간) 변화량

$$\frac{dB}{dt} = \frac{d}{dt} \left(\int_V \beta \rho dV \right)$$

CV안의 유입 B

$$\beta \rho dV_{in,1} + \beta \rho dV_{in,2} + \dots$$

$$dV_{in,1} = v_{in,1} \cdot dA_{in,1} \cdot dt \cdot \cos \theta_{in,1}$$

$$dV_{in,2} = v_{in,2} \cdot dA_{in,2} \cdot dt \cdot \cos \theta_{in,2}$$

⋮

$$\int_{\text{CS}} dV_{in} = \int_{\text{CS}} v_{in} \cos \theta_{in} dt dA_{in}$$

$$\int_{\text{CS}} \beta \rho v \cos \theta dt dA_{in}$$

CV 밖으로 유출 B

$$\int_{\text{CS}} \beta \rho v \cos \theta dt dA_{out}$$

$$\frac{d}{dt}(B_{\text{tot}}) = \frac{d}{dt} \left(\int_V \beta \rho dV \right) + \underbrace{\int_{\text{CS}} \beta \rho v \cos \theta dA_{in}}_{= v \cdot \cos \theta \cdot dA = (v \cdot n) dA} - \underbrace{\int_{\text{CS}} \beta \rho v \cos \theta dA_{out}}_{= (v \cdot n) dA}$$

$$\frac{d}{dt}(B_{\text{tot}}) = \frac{d}{dt} \left(\int_V \beta \rho dV \right) + \int_{\text{CS}} \beta \rho (v \cdot n) dA$$

Dynamics & Rigid Particles : $B_{\text{tot}} = mU$, $\beta = B/m = U$, $\frac{d}{dt} \left(\int_V \beta \rho dV \right) = 0$

$$\frac{d(mU)}{dt} = F = \int_{\text{CS}} (n) \rho (v \cdot n) dA = \rho A U (v \cdot n)$$

$$\therefore F = \rho A U (v \cdot n)$$