

# Mécaflu chap. 0 : Statique des fluides

1.1.  $f(t+dt) = f(t) + \frac{df}{dt}(t) \times dt$  au voisinage de  $t$  Taylor 1<sup>er</sup> ordre

1.2.  $d\vec{on} = \vec{v} dt$   $\vec{v} = x \vec{e}_x + y \vec{e}_y + z \vec{e}_z$

$$= \begin{pmatrix} x dt \\ y dt \\ z dt \end{pmatrix} = \begin{pmatrix} dx \\ dy \\ dz \end{pmatrix}$$

1.3.  $T(M)$   
 $T(\vec{r})$   $\vec{r} = \vec{OM}$  avec  $O$  origine d'un repère.

$T(x, y, z)$

$$\left( \frac{\partial T}{\partial x} \right)_{y, z} \quad \frac{\partial T}{\partial x} \quad f(x, y) = 2x^2y - 4 \ln(x)e^y$$

$$\frac{\partial f}{\partial x} = 4yx - \frac{4e^y}{x}$$

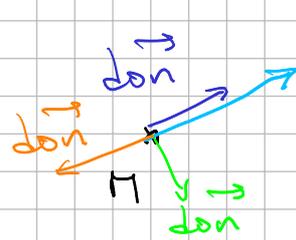
$$\frac{\partial}{\partial x} \left( \frac{\partial T}{\partial y} \right) = \frac{\partial}{\partial y} \left( \frac{\partial T}{\partial x} \right) = \frac{\partial^2 T}{\partial x \partial y}$$

1.4.  $T(x, y, z)$

$$dT = \frac{\partial T}{\partial x} dx + \frac{\partial T}{\partial y} dy + \frac{\partial T}{\partial z} dz$$

$$dT = \vec{\text{grad}}(T) \cdot d\vec{on}$$

$$\begin{pmatrix} \frac{\partial T}{\partial x} \\ \frac{\partial T}{\partial y} \\ \frac{\partial T}{\partial z} \end{pmatrix} \begin{pmatrix} dx \\ dy \\ dz \end{pmatrix}$$



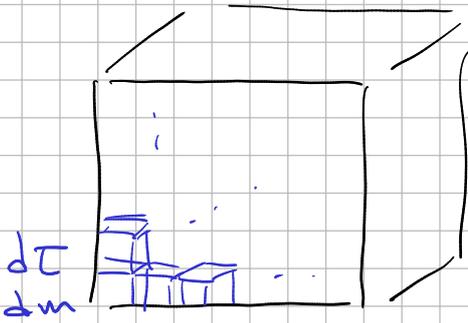
$\vec{\text{grad}}(T)$

$dT > 0 \quad T \uparrow$   
 $dT < 0 \quad T \downarrow$   
 $dT = 0 \quad T \text{ CR}$

2.2.



$$dm \stackrel{\text{def}}{=} \underbrace{\rho(\mathbf{r})}_{\text{kg m}^{-3}} dV \quad \text{m}^3$$

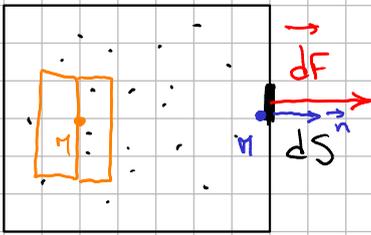


macro vol.  $V$ , masse  $m_{\text{tot}}$

Extensivität:  $m_{\text{tot}} = \iiint_{\text{vol. } V} dm$

$$m_{\text{tot}} = \iiint_{M \in \text{vol } V} \rho(\mathbf{r}) dV$$

3.1.



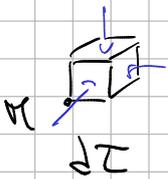
$$dF \stackrel{\text{def}}{=} \underbrace{P(\mathbf{r})}_{>0} dS \vec{n}$$

$$= \underbrace{P(\mathbf{r})}_{\substack{N \cdot m^{-2} \\ P_e}} dS \vec{n}$$

pres<sup>o</sup> continue



3.2.



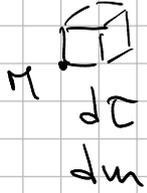
$$\vec{dF}_{\text{pres}} = dm \vec{g} = \underbrace{(\rho(\mathbf{r}) \vec{g})}_{\substack{\text{def} \\ \vec{f}_{\text{pres}}}} \cdot dV$$

$$\vec{f}_{\text{pres}} = \rho \vec{g}$$

$N m^{-3}$

$$\vec{dF}_{\text{pres tot}} \stackrel{\text{def}}{=} \underbrace{-\text{grad}(P)}_{\vec{f}_{\text{presion}}} \cdot dV$$

4.1.

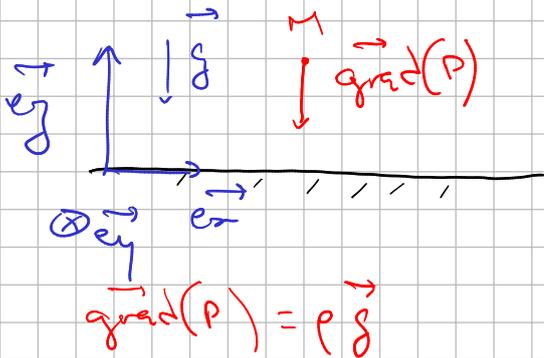


PFD dans réf. terrestre galiléenne :

$$dm \times \vec{a} = \vec{dF}_{per} + \vec{dF}_{presso\ tot}$$

car statique  $= (p\vec{g}) \cancel{dz} + (-\vec{grad}(P)) \cancel{dz}$

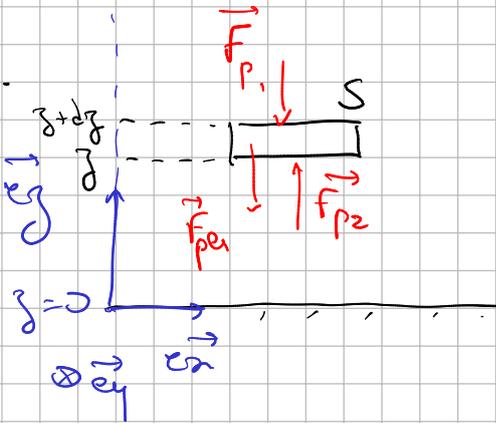
$$-\vec{grad}(P) + p\vec{g} = \vec{0} \quad \text{Nm}^{-3}$$



$$\begin{aligned} (\vec{e}_x): & -\frac{dp}{dx} + 0 = 0 \\ (\vec{e}_y): & -\frac{dp}{dy} + 0 = 0 \\ (\vec{e}_z): & -\frac{dp}{dz} - p g = 0 \end{aligned} \quad \left. \vphantom{\begin{aligned} (\vec{e}_x): \\ (\vec{e}_y): \\ (\vec{e}_z): \end{aligned}} \right\} P(z)$$

$$\frac{dP}{dz} + P g = 0$$

4.2.



$$d\tau = S \times dz$$

PFD syok:  $\vec{0} = \vec{F}_{per} + \vec{F}_{p1} + \vec{F}_{p2}$

$$\begin{aligned} \vec{F}_{p1} &= -P(z+dz) \times S \vec{e}_z \\ \vec{F}_{p2} &= P(z) \times S \vec{e}_z \\ \vec{F}_{per} &= dm \vec{g} = -P(z) d\tau g \vec{e}_z \end{aligned}$$

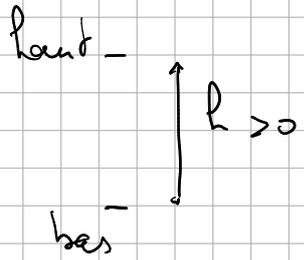
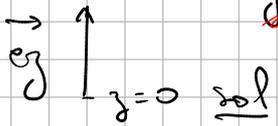
$$\begin{aligned} (\vec{e}_z): & \left[ P(z) - P(z+dz) \right] S - P(z) g S dz = 0 \\ & - \frac{dP}{dz}(z) dz \end{aligned} \quad \boxed{\frac{dP}{dz} + P g = 0}$$

$$5.2. \quad \frac{dP}{dz} + \rho g = 0$$

$$P(z) = -\rho g z + A$$

$$P(z=0) = P_0 \Rightarrow P_0 = 0 + A$$

$$P(z) = P_0 - \rho g z \quad \text{évol° affine.}$$



$$P_{\text{bas}} = P_{\text{haut}} + \rho g h$$

$$6.1. \quad \overline{M_{\text{air}}} = 0,8 M_{N_2} + 0,2 M_{O_2}$$

$$= 0,8 \times 28 + 0,2 \times 32$$

$$= 28,8 \text{ g mol}^{-1} = \underline{29 \text{ g mol}^{-1}}$$

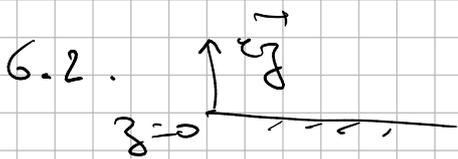
$$Z_N = 7 \quad A_N = 14$$

$$M_{N_2} = 28 \text{ g mol}^{-1}$$

$$PV = nRT_0$$

$$P \overline{V} = \frac{m}{M_{\text{air}}} RT_0$$

$$P = \frac{P_{\text{air}}}{RT_0}$$



$$\frac{dP}{dz} + \rho(z) g = 0$$

$$\frac{dP}{dz} + \frac{n_{\text{air}} g}{RT_0} P = 0$$

$$P(z) = A e^{-\frac{n_{\text{air}} g z}{RT_0}}$$

$$P(z=0) = P_0$$

$$P(z) = P_0 e^{-\frac{n_{\text{air}} g z}{RT_0}}$$

→ "  $e^{-\frac{t}{RC}} \leftrightarrow e^{-t/\tau}$ ,  $\tau = RC$  "  $\tau = \text{tps } X^{\text{is}}$

Ici  $e^{-z/H_c}$  avec

$$H_c = \frac{RT_0}{n_{\text{air}} g}$$

$$\underline{AN^{\text{is}}} : \quad H_c = \frac{8 \times 300}{30 \times 10^{-3} \times 10}$$

$$= 8 \times 10^3 \text{ m} = \underline{8 \text{ km}}$$