Ecoulements visqueux naturels et industriels

Prérequis :

Cinématique des fluides parfaits

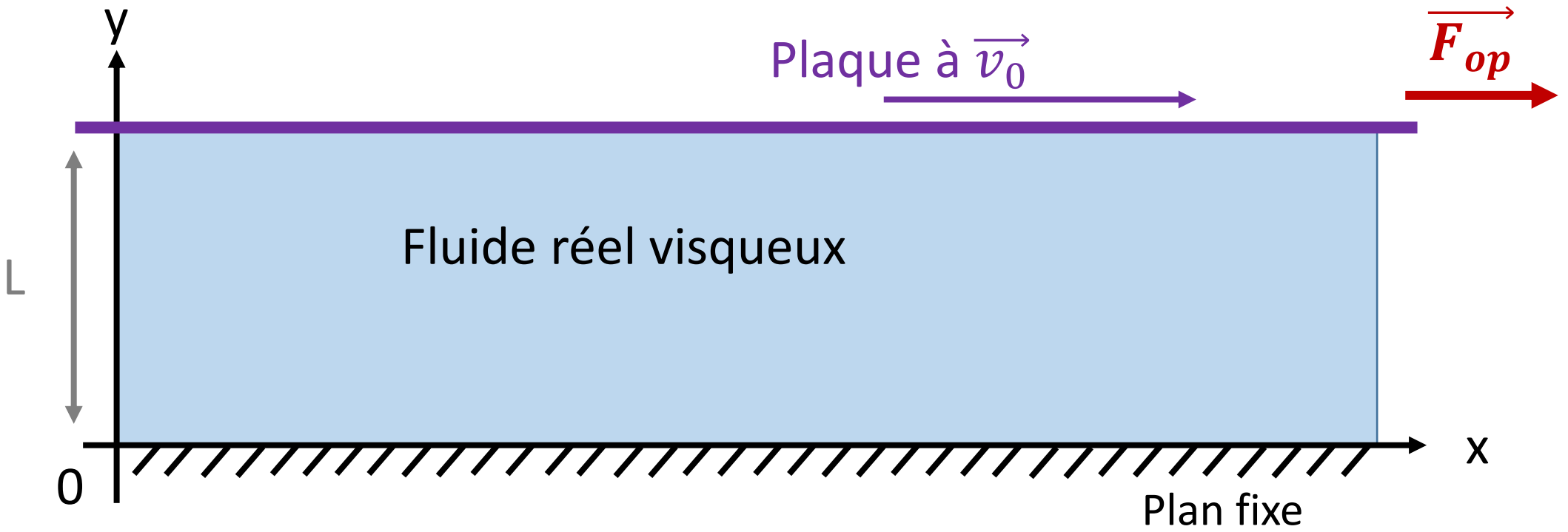
Description Eulerienne et Lagrangienne

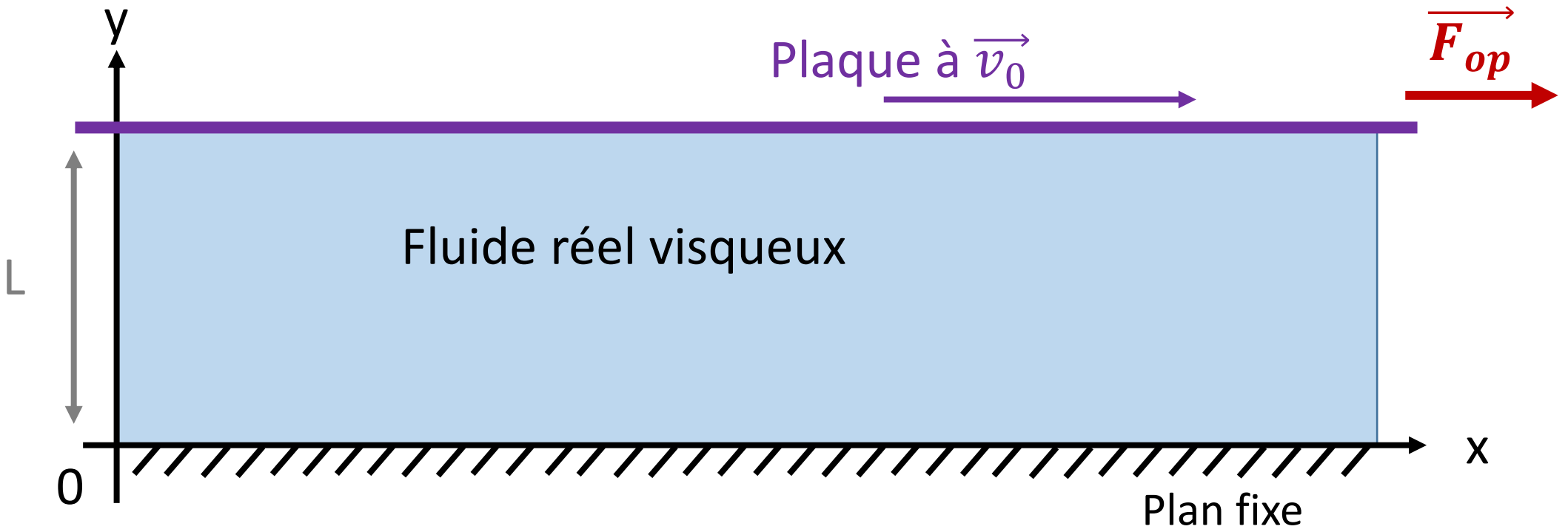
Fluide et Ecoulement incompréssibles

Equation de conservation de la masse

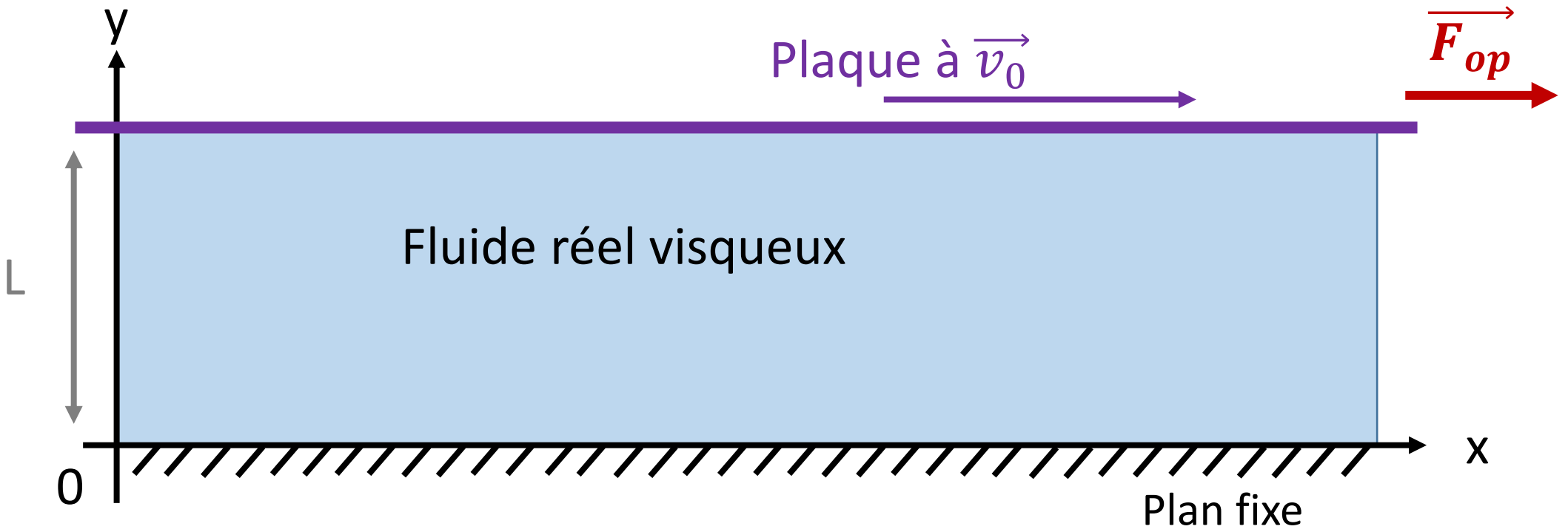
Equation d'Euler

Théorème de Bernoulli


y
Plaque à $\overrightarrow{v_0}$
$\overrightarrow{F_{op}}$
Fluide réel visqueux
L
0
x
Plan fixe

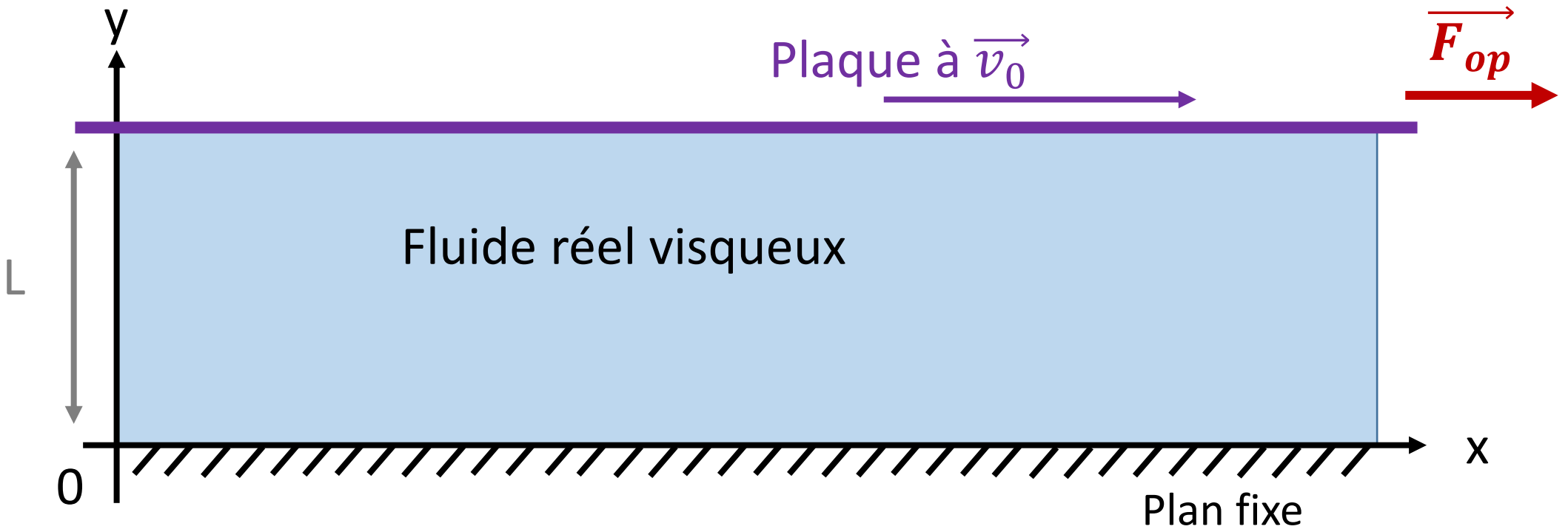


On mesure $\overrightarrow{F_{op}}$ proportionnelle à : $\frac{Sv_0}{L}$



On mesure $\overrightarrow{F_{op}}$ proportionnelle à : $\frac{Sv_0}{L}$

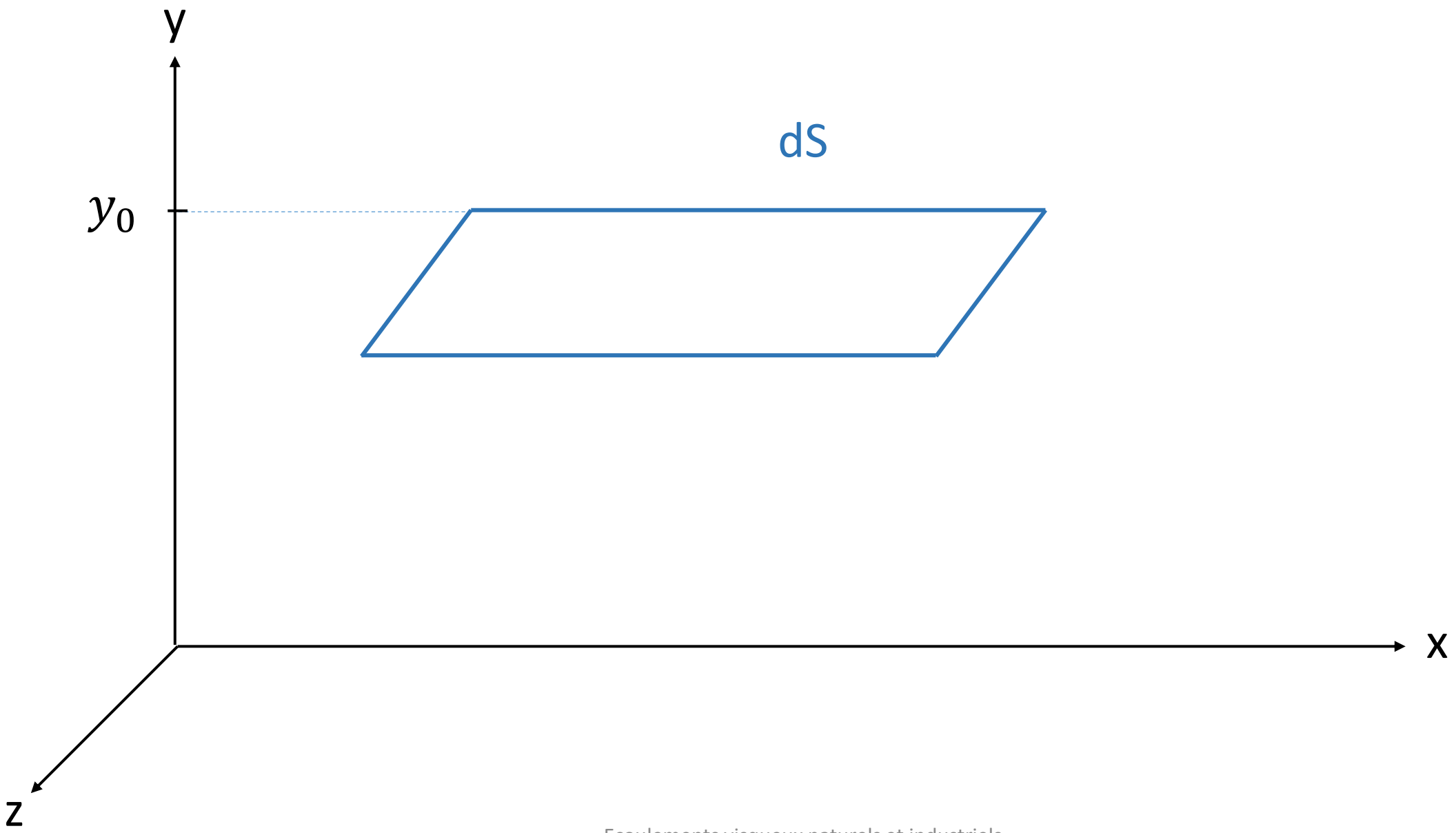
La viscosité dynamique η est le coefficient de proportionnalité.

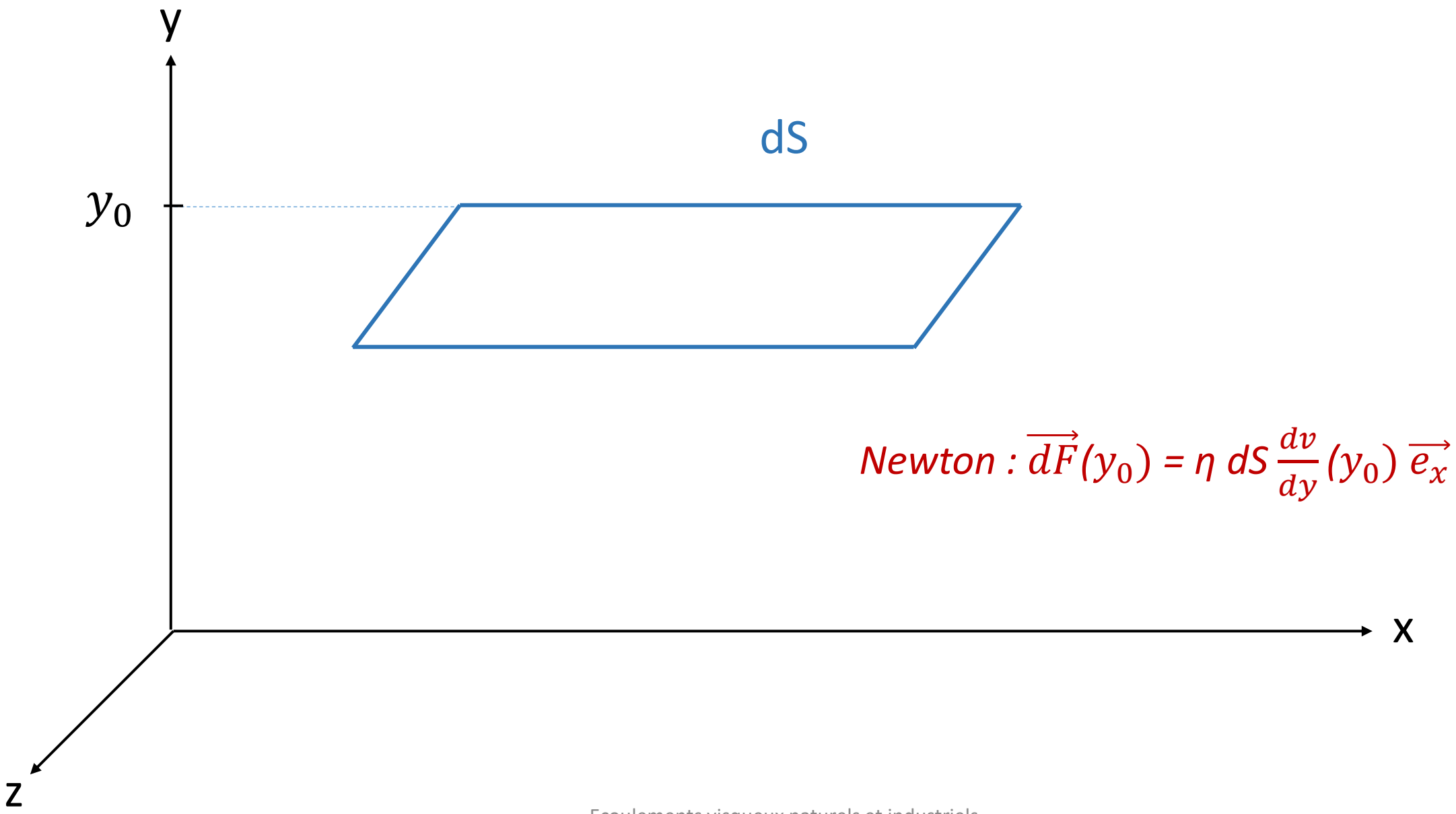


$$\overrightarrow{F_{op}} = \eta \frac{S v_0}{L} \overrightarrow{e_x}$$

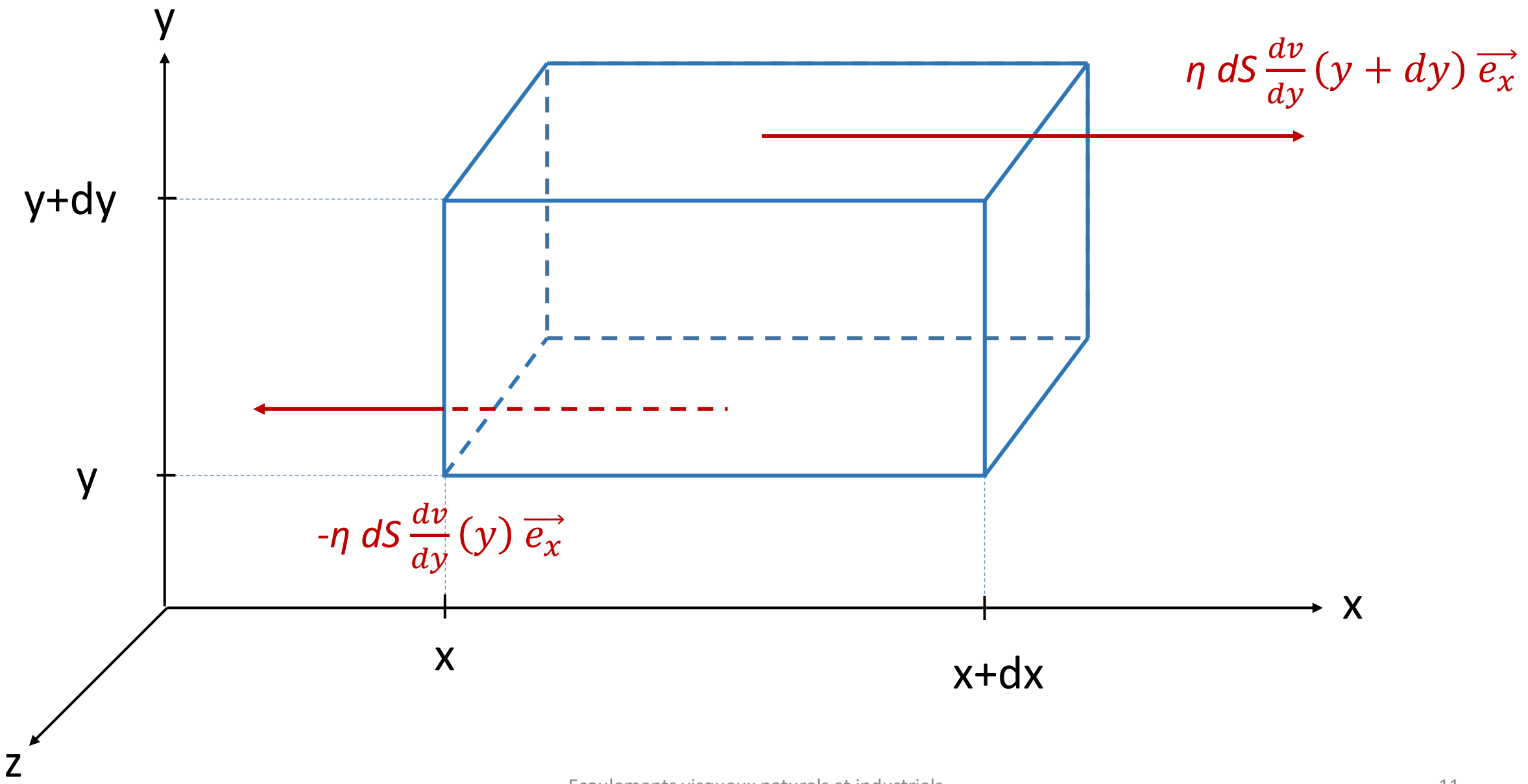
ODG η :

- Air : $1{,}8.10^{-5}$ Pa.s
- Eau : $1{,}0.10^{-3}$ Pa.s
- Huile : 0,1 Pa.s
- Glycerine : environ 1 Pa.s


y
dS
y_0
x
z

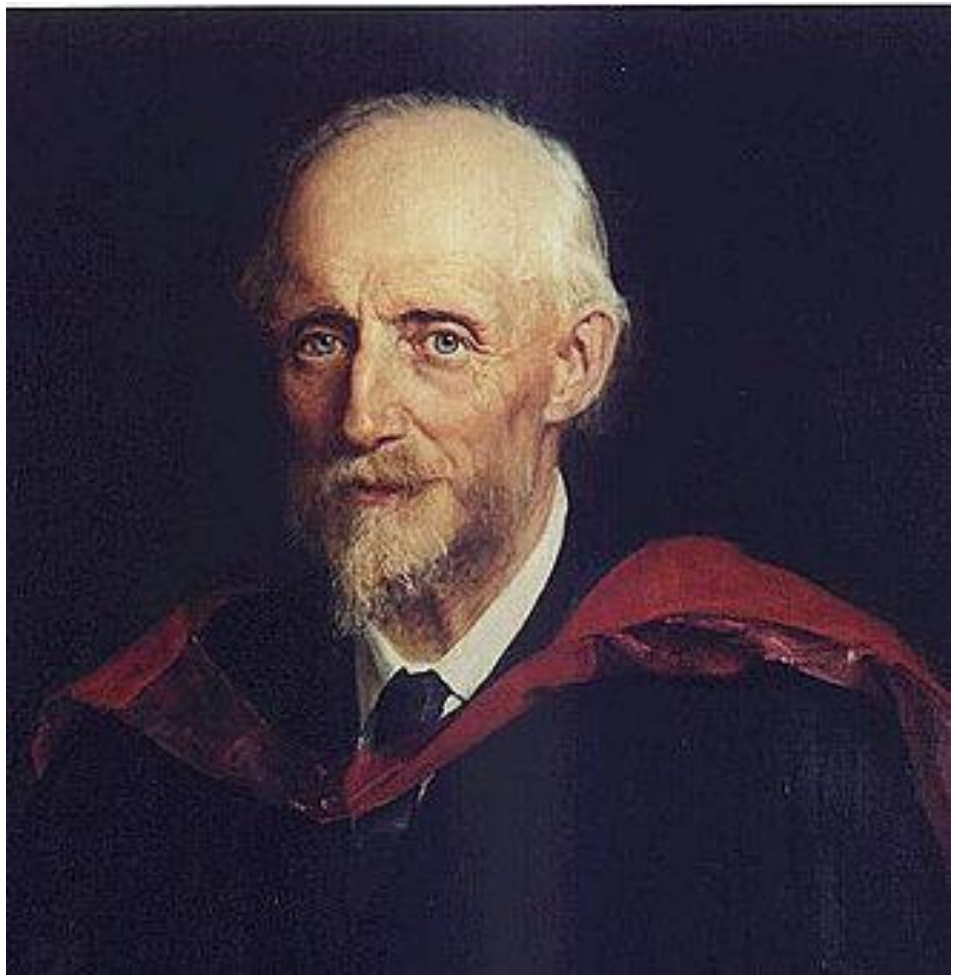


Newton : $\overrightarrow{dF}(y_0) = \eta\, dS \frac{dv}{dy}(y_0)\, \overrightarrow{e_x}$

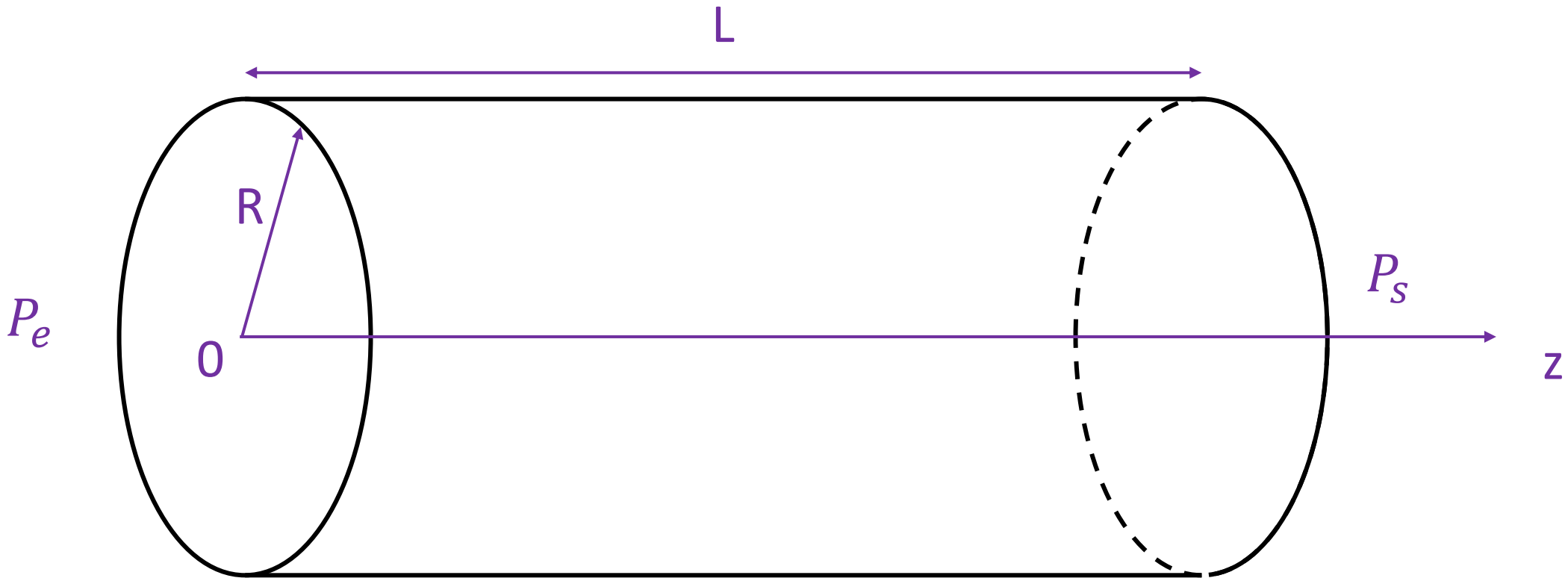

y
y+dy
y
x
x+dx
z
$\eta\ dS \frac{dv}{dy}(y+dy)\ \overrightarrow{e_x}$
$-\eta\ dS \frac{dv}{dy}(y)\ \overrightarrow{e_x}$

Le $\vec{\Delta}$ n'est simple qu'en cartésien :

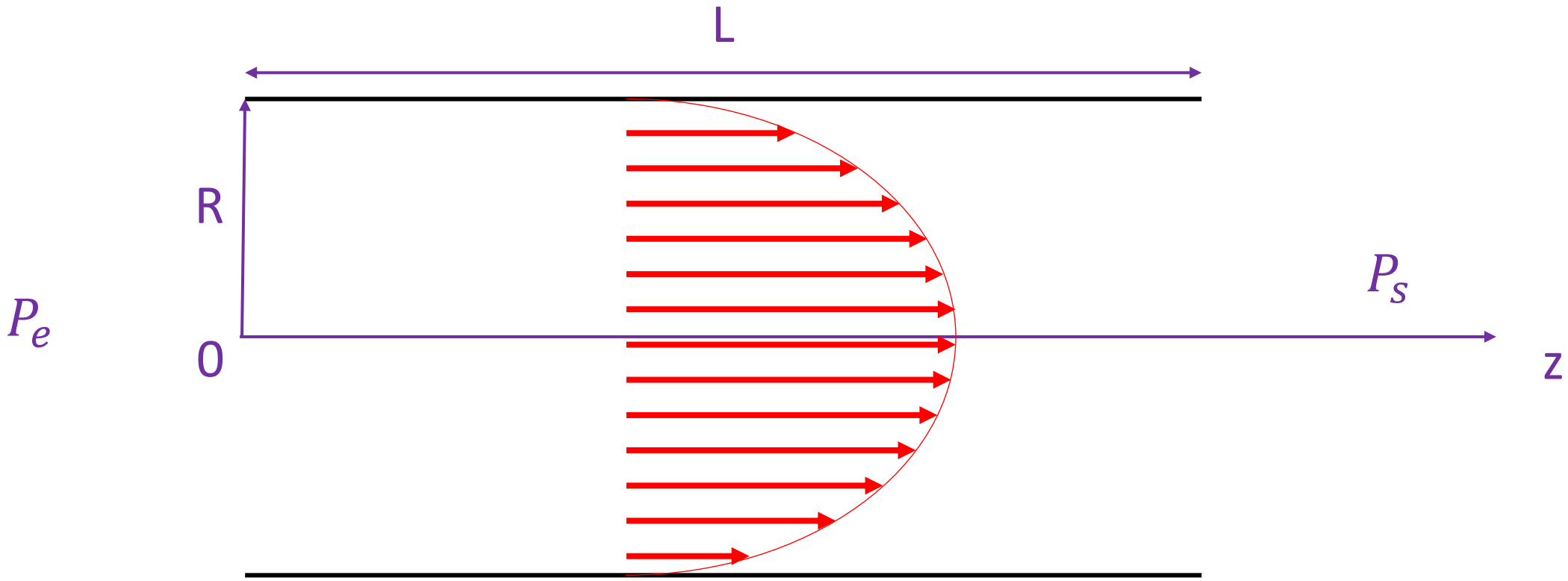
$$\vec{\Delta}\vec{v} = \left| \begin{array}{l} \Delta v_x = \frac{\partial^2 v_x}{\partial x^2} + \frac{\partial^2 v_x}{\partial y^2} + \frac{\partial^2 v_x}{\partial z^2} \\ \Delta v_y = \frac{\partial^2 v_y}{\partial x^2} + \frac{\partial^2 v_y}{\partial y^2} + \frac{\partial^2 v_y}{\partial z^2} \\ \Delta v_z = \frac{\partial^2 v_z}{\partial x^2} + \frac{\partial^2 v_z}{\partial y^2} + \frac{\partial^2 v_z}{\partial z^2} \end{array} \right.$$

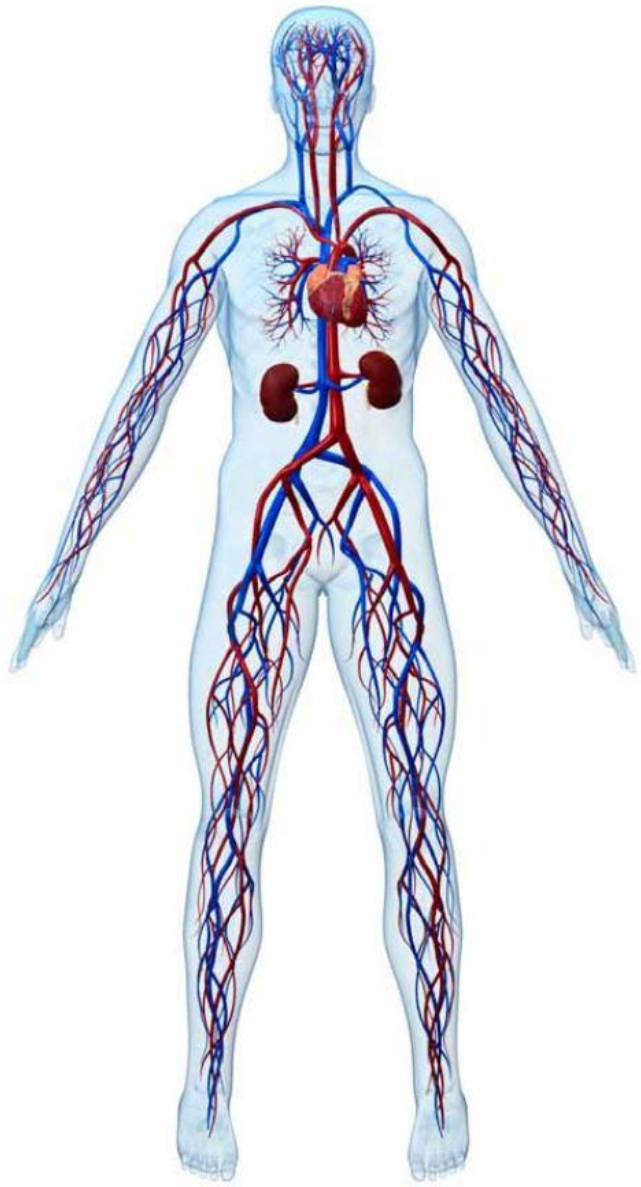


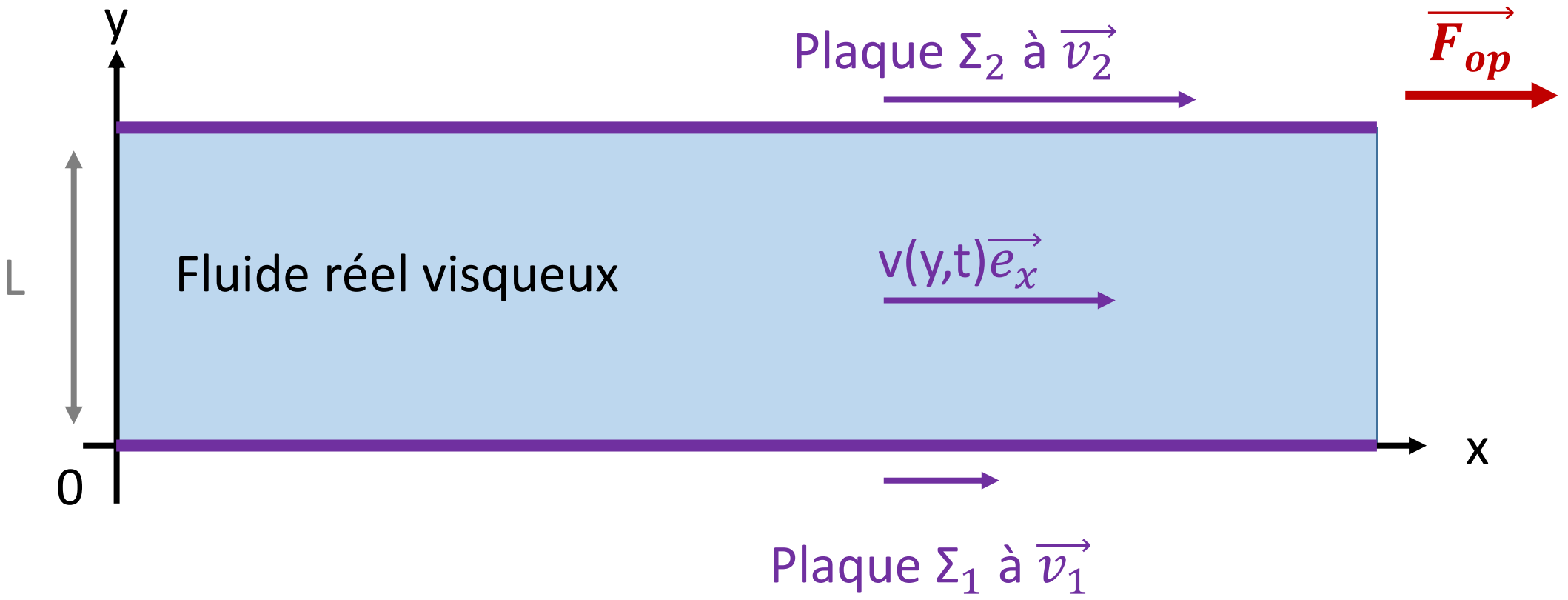
Osborne Reynolds (1842-1912)



$P_e > P_s$ $\qquad$ $P_e - P_s = \Delta P > 0$


L
R
P_e
P_s
0
z




y
Plaque Σ_2 à $\overrightarrow{v_2}$
$\overrightarrow{F_{op}}$
L
Fluide réel visqueux
$v(y,t)\overrightarrow{e_x}$
x
0
Plaque Σ_1 à $\overrightarrow{v_1}$