Dans le cadre de la
Formation « Hydraulique Fondamentale »
Unité de Formation pour la Performance Industrielle

en collaboration avec l'INP-ENSEEIHT

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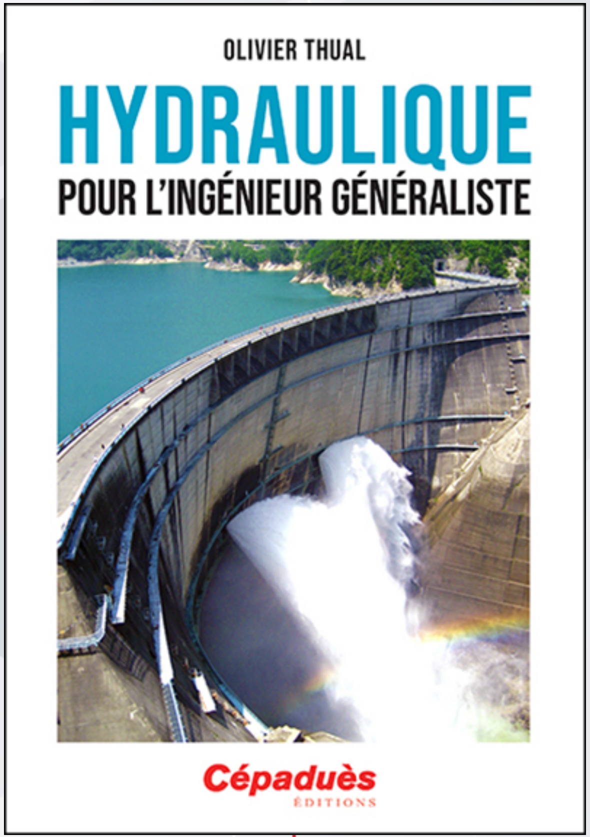
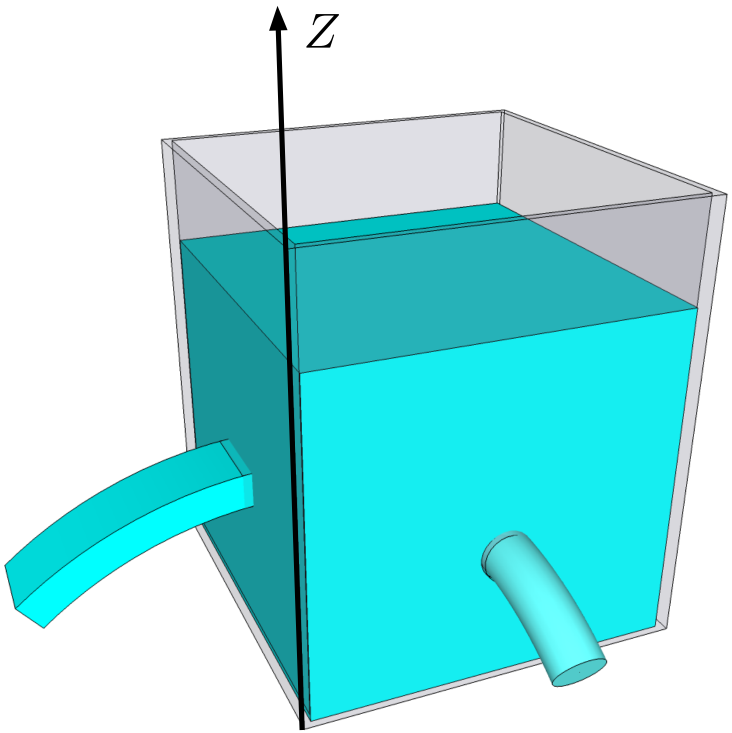
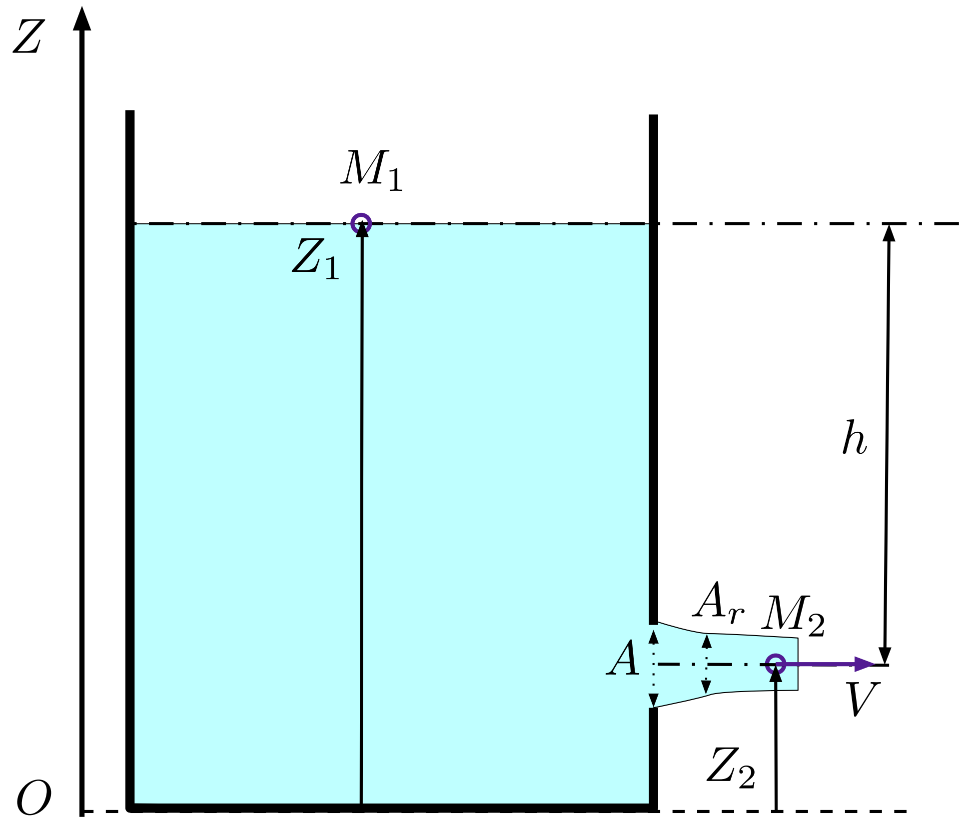


Chapitre 7
Ouvertures

Débit théorique de Toricelli

$$H = \frac{P_a}{\rho\, g} + Z_1 = \frac{P_a}{\rho\, g} + Z_2 + \frac{V_{theo}^2}{2\, g} \quad \Longrightarrow \quad V_{theo} = \sqrt{2\, g\, h}$$





Débit réel à travers un orifice

$$V = C_v \, V_{theo}$$

$$A_{contra} = C_a \, A$$

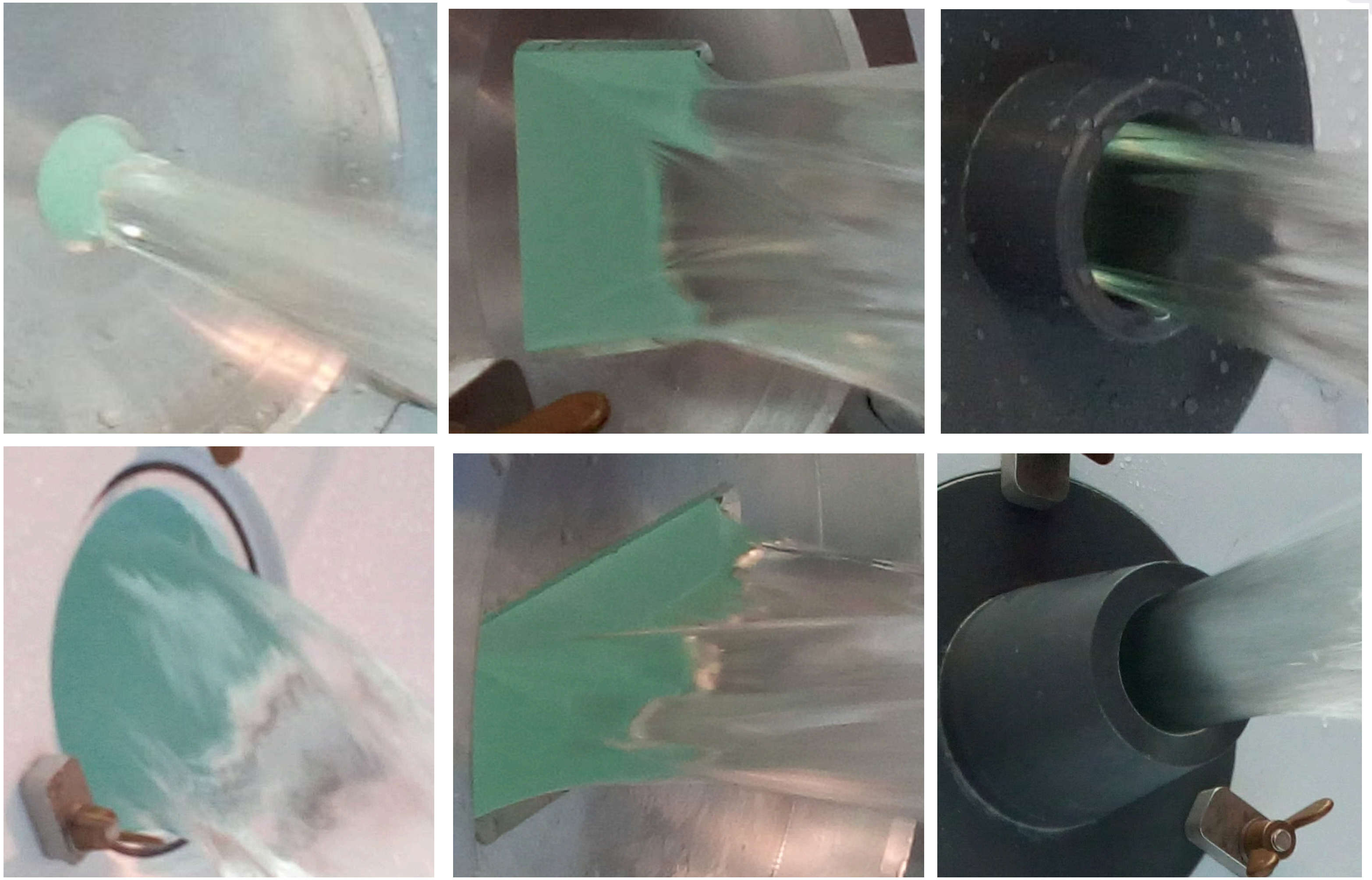
$$C_v \sim 0,98$$

$$C_a \sim 0,60$$

$$Q = \mu \, A \sqrt{2 \, g \, h} \quad \text{avec} \quad \mu = C_a \, C_v = 0,59$$

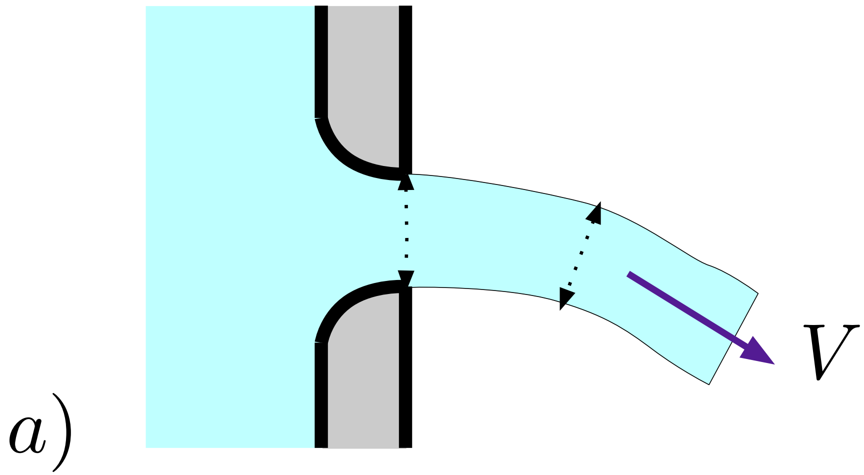
Le coefficient correcteur dépend de la forme des orifices ou ajutages

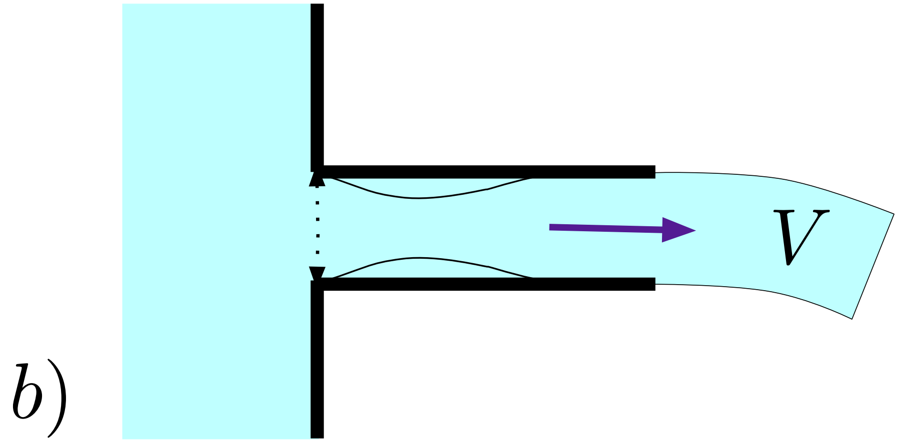
Orifices et ajutages



Coefficients correcteurs

Paroi moulée : $\mu = 0,96$ Ajutage : $\mu = 0,82$





Démonstration dans le cas d'un ajutage :

Perte de charge singulière : $h_s = K\, V^2/(2\,g)$ avec $K = 0,5$

$$h - h_s = V^2/(2\,g) \implies V = C_v \sqrt{2\,g\,h} \quad \text{avec} \quad C_v = 1/\sqrt{1.5} = 0,82$$

$$A_{contra} = A \implies \mu = C_v = 0,82$$

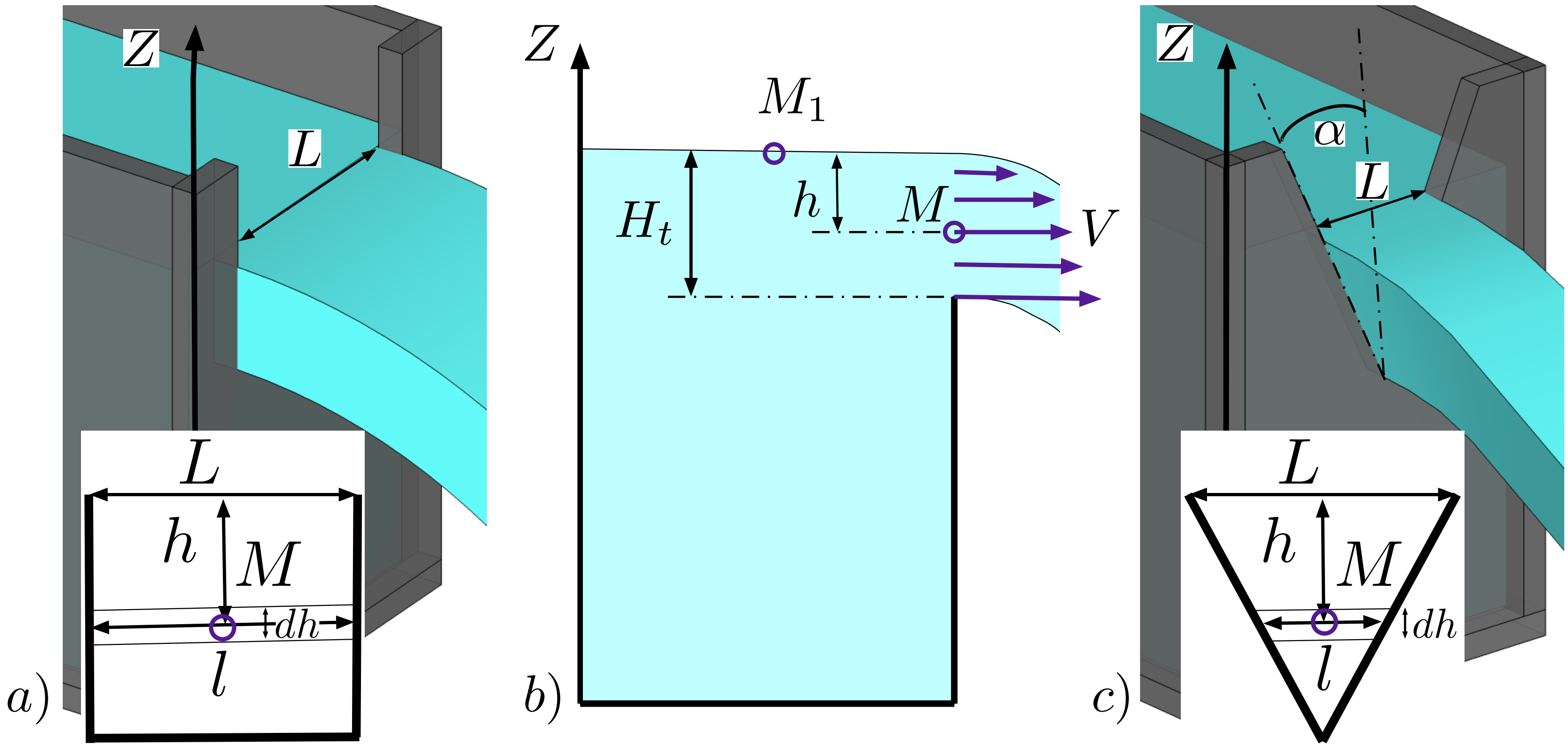
Débit à travers des déversoirs

$$Q_{rect} = \mu_{rect} \, L \, \sqrt{2\, g} \, H_t^{3/2}$$

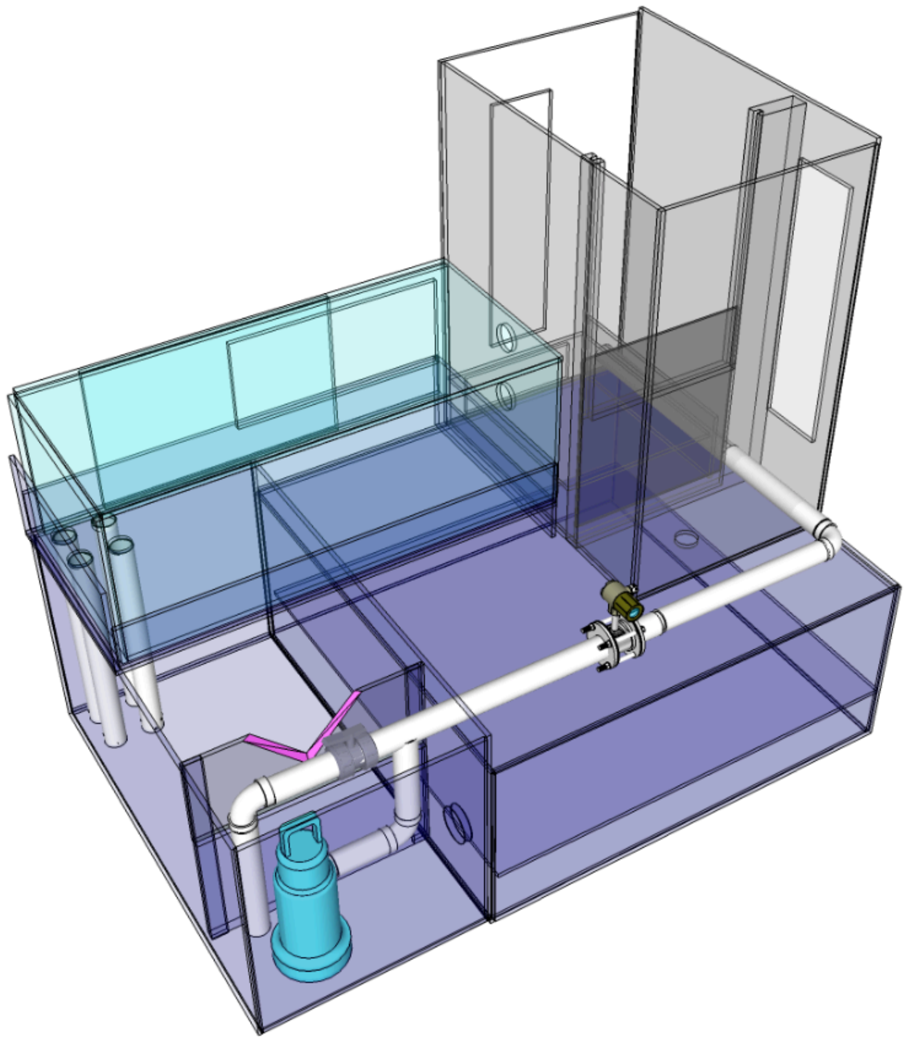
avec $\mu_{rect} = 0,415$

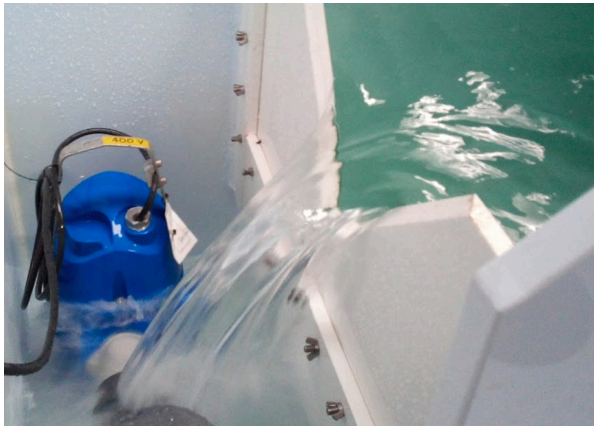
$$Q_{tria} = \mu_{tria} \, \frac{8}{15} \tan\alpha \, \sqrt{2\, g} \, H_t^{5/2}$$

avec $\mu_{tria} = 0,58$



Maquette orifices et ajutages



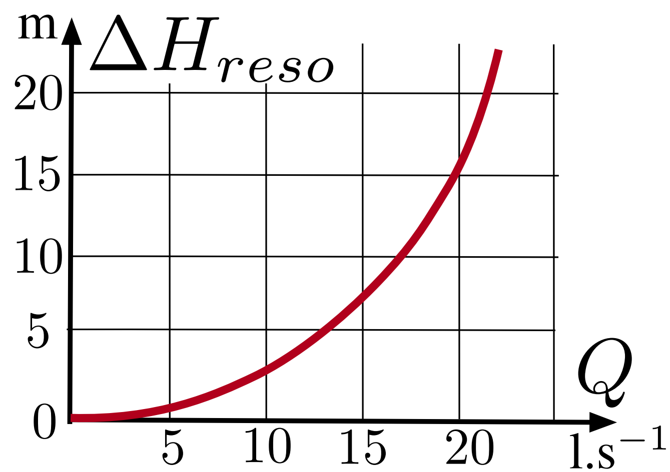


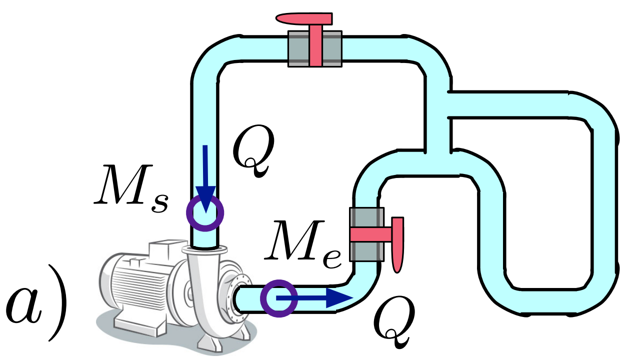
Courbe caractéristique d'un réseau

$$\Delta H_{reso} = H_e - H_s$$

Réseau en charge

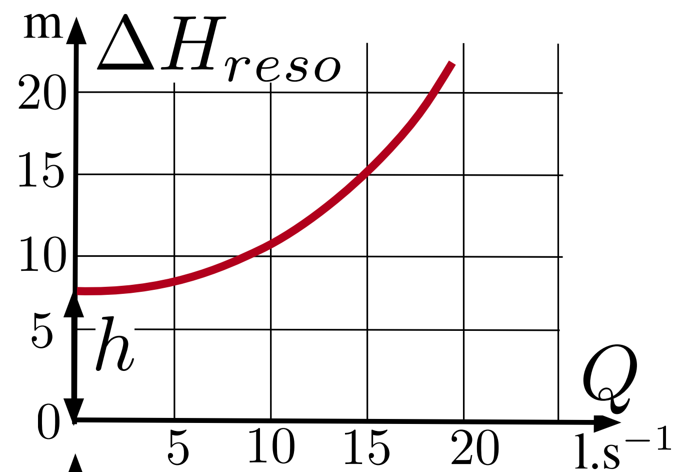
$$\Delta H_{reso} = h_f + h_s$$

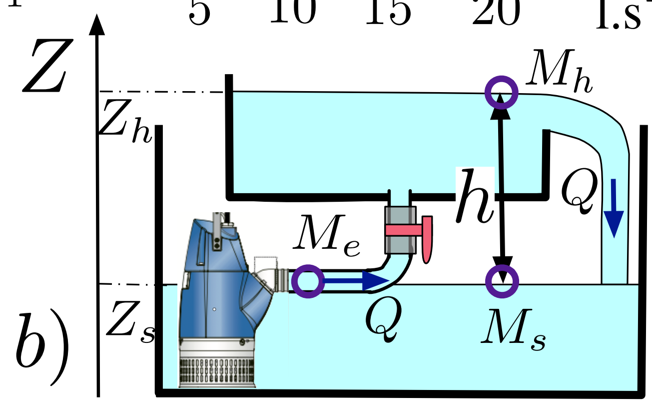




Réseau avec surface libre

$$\Delta H_{reso} = h_f + h_s + h$$



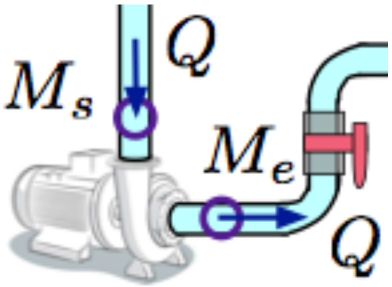


Courbe caractéristique d'une pompe

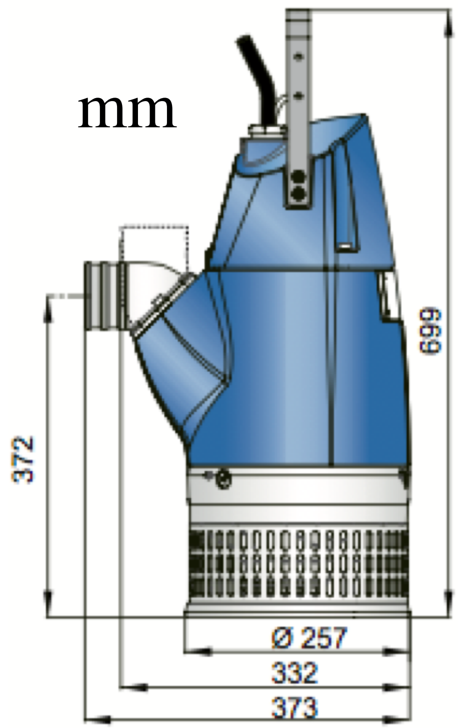
$$\Delta H_{pomp}(Q) = H_e - H_s$$

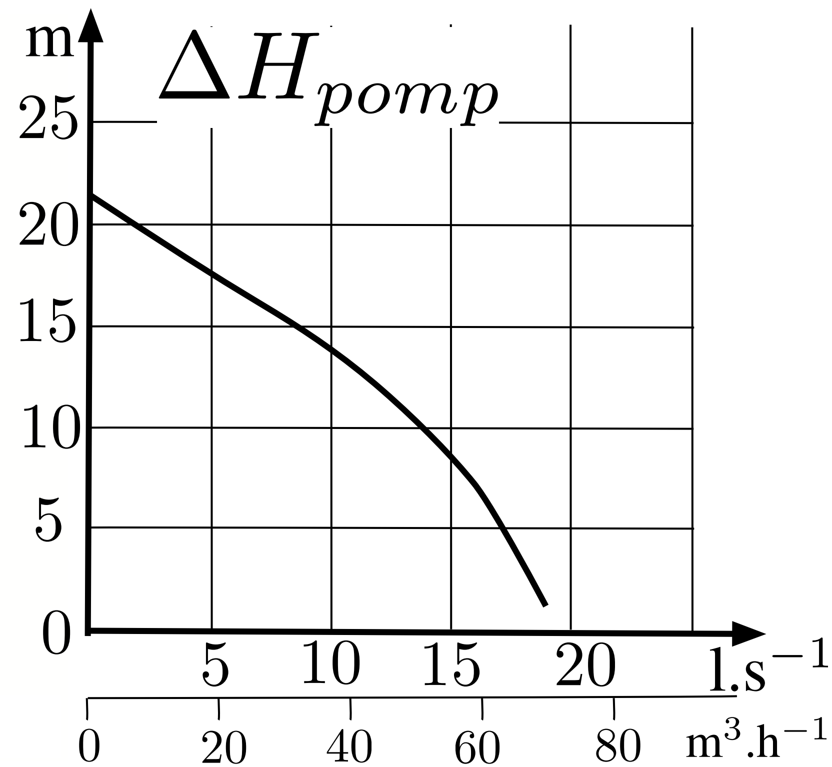
Hauteur de relèvement :

$$\Delta H_{pomp}(0)$$

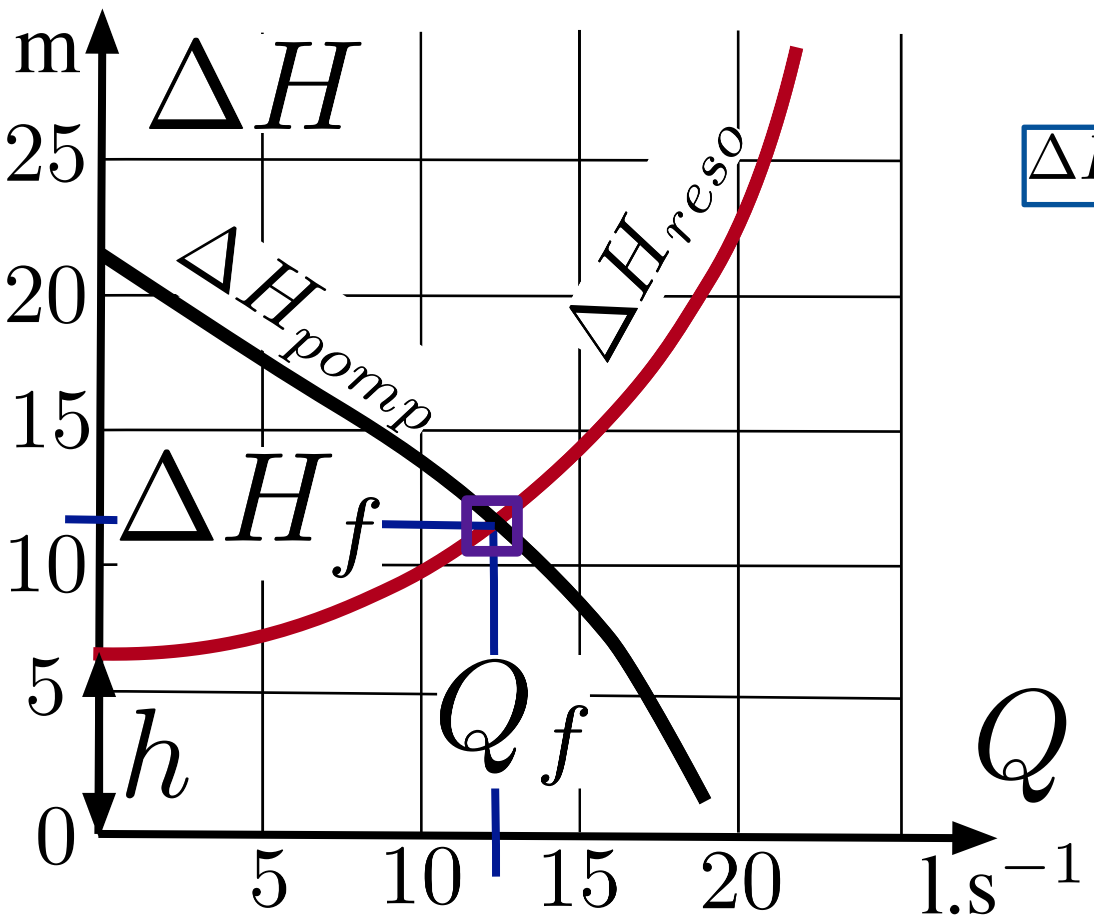


Pompe immergé de la maquette orifices et ajutages

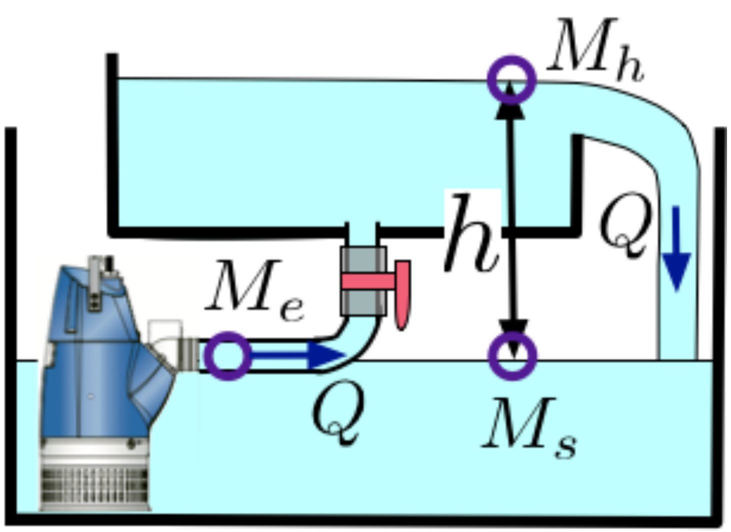




Point de fonctionnement



$$\Delta H_{pomp}(Q_f) = \Delta H_{reso}(Q_f)$$



Exemple de réseau

$h = Z_h - Z_s = 2$ m

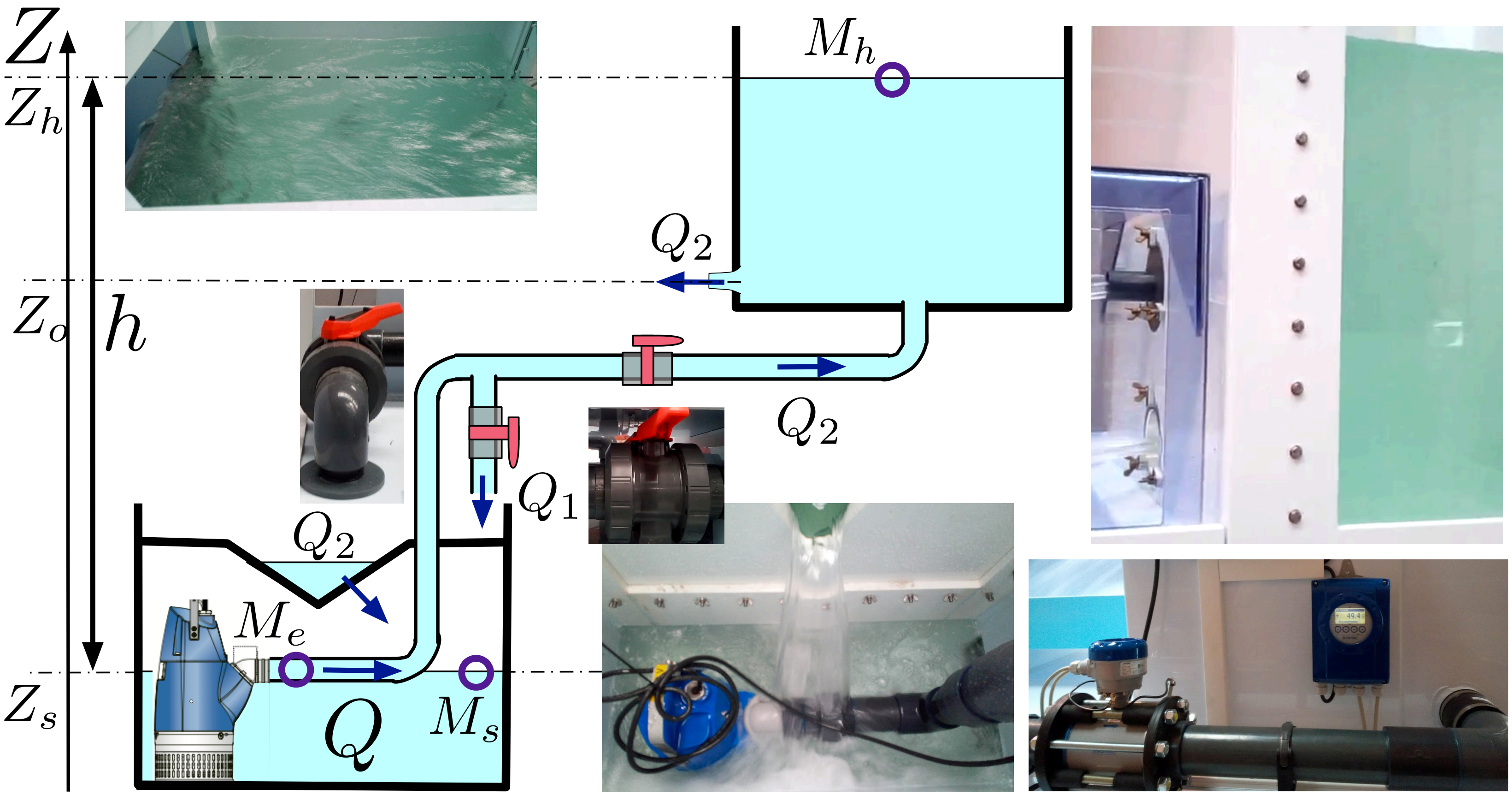
$Z_o - Z_s = 1$ m

$\alpha = \pi/4$

Pertes de charges :

$\alpha_1 \, Q_1^2$

$\alpha_2 \, Q_2^2$



Calcul de débits

Modélisation de la pompe :

$$\Delta H_{pomp}(Q) = H_p \left[1 - (Q/Q_m)^2\right]$$

$H_p = 20$ m $\quad Q_m = 20$ l/s

Premier cas :

$Q_1 = 0 \Longrightarrow Q_2 = 14$ l/s

Calculer : α_2

Deuxième cas :

$Q_2 = 10$ l/s

Calculer : α_1