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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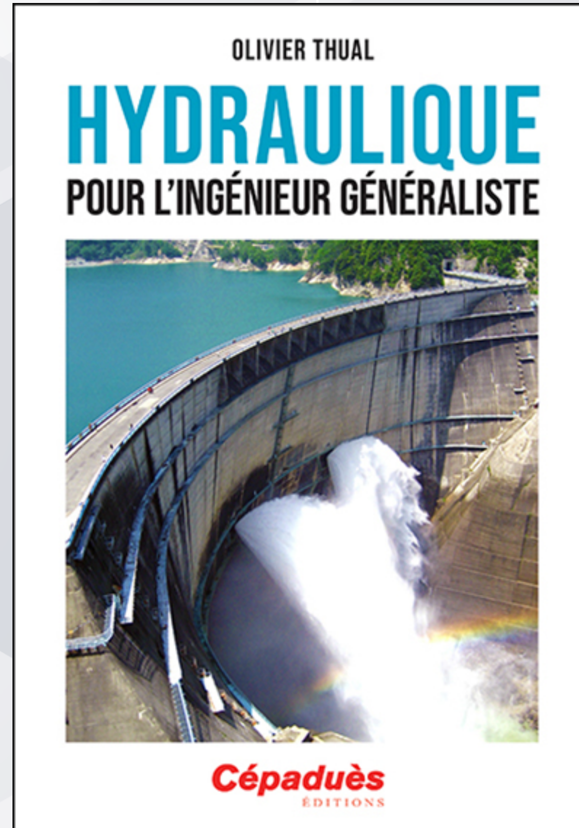
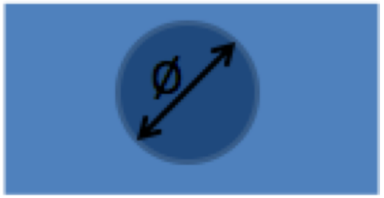


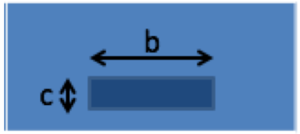
Chapitre 7
Ouvertures

15. Orifices et ajutages

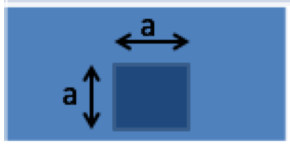
$$Q = \mu A \sqrt{2 g h}$$



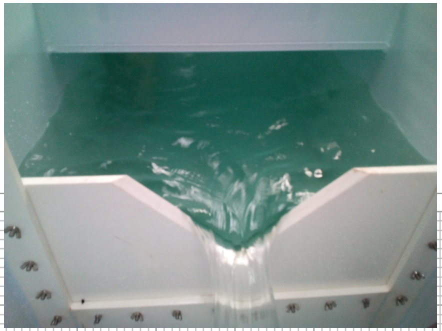
Ø = 16 mm
Ø = 22 mm
Ø = 31 mm
Ø = 42 mm
Ø = 60 mm

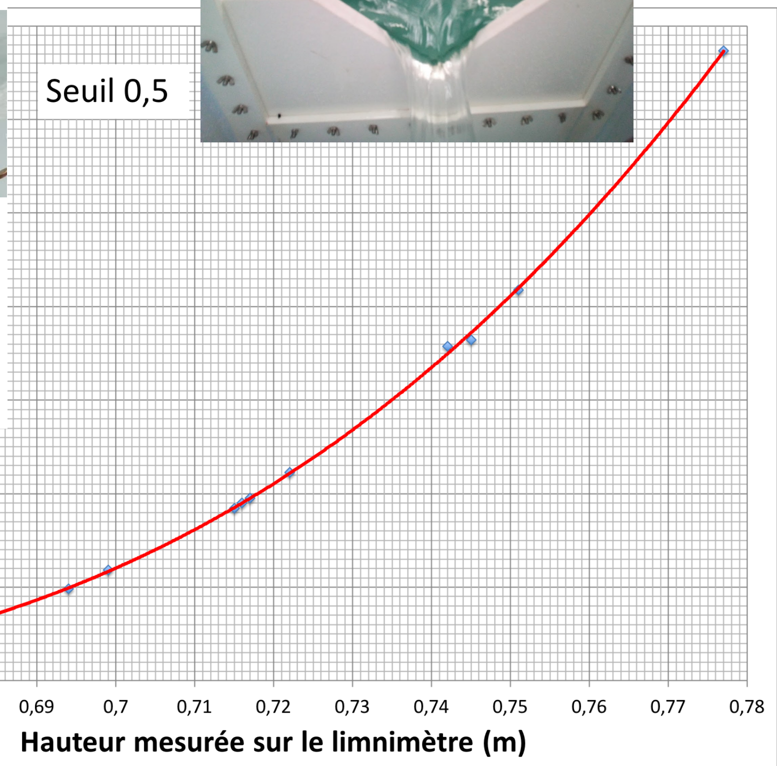


b x c = 45 x 15 mm²
b x c = 65 x 21 mm²
b x c = 92 x 30 mm²



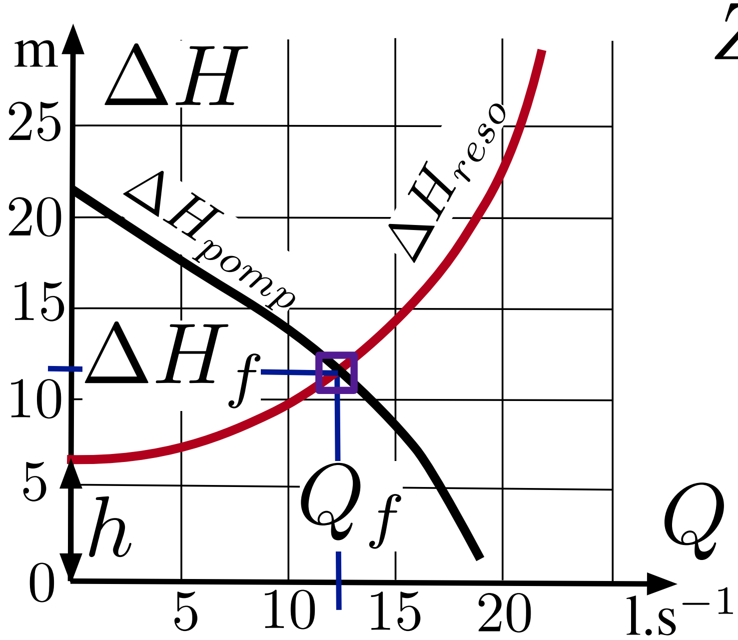
a = 26 mm
a = 37 mm
a = 53 mm

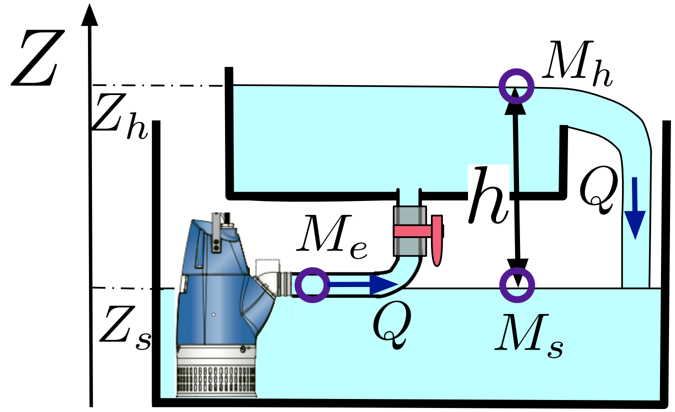


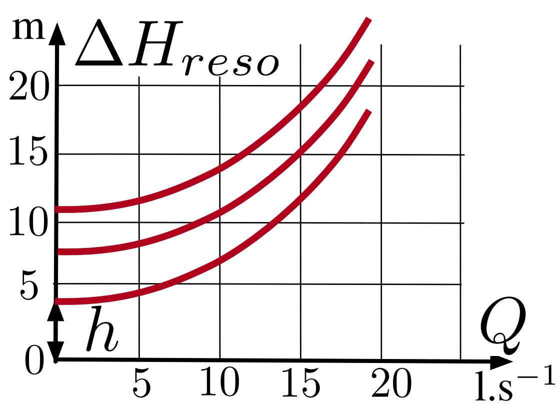


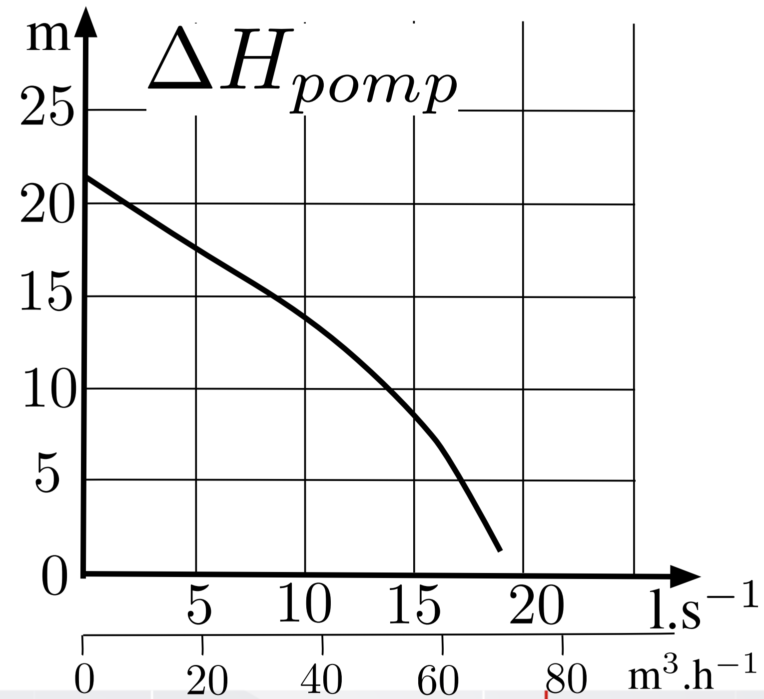
16. Point de fonctionnement

Exilco



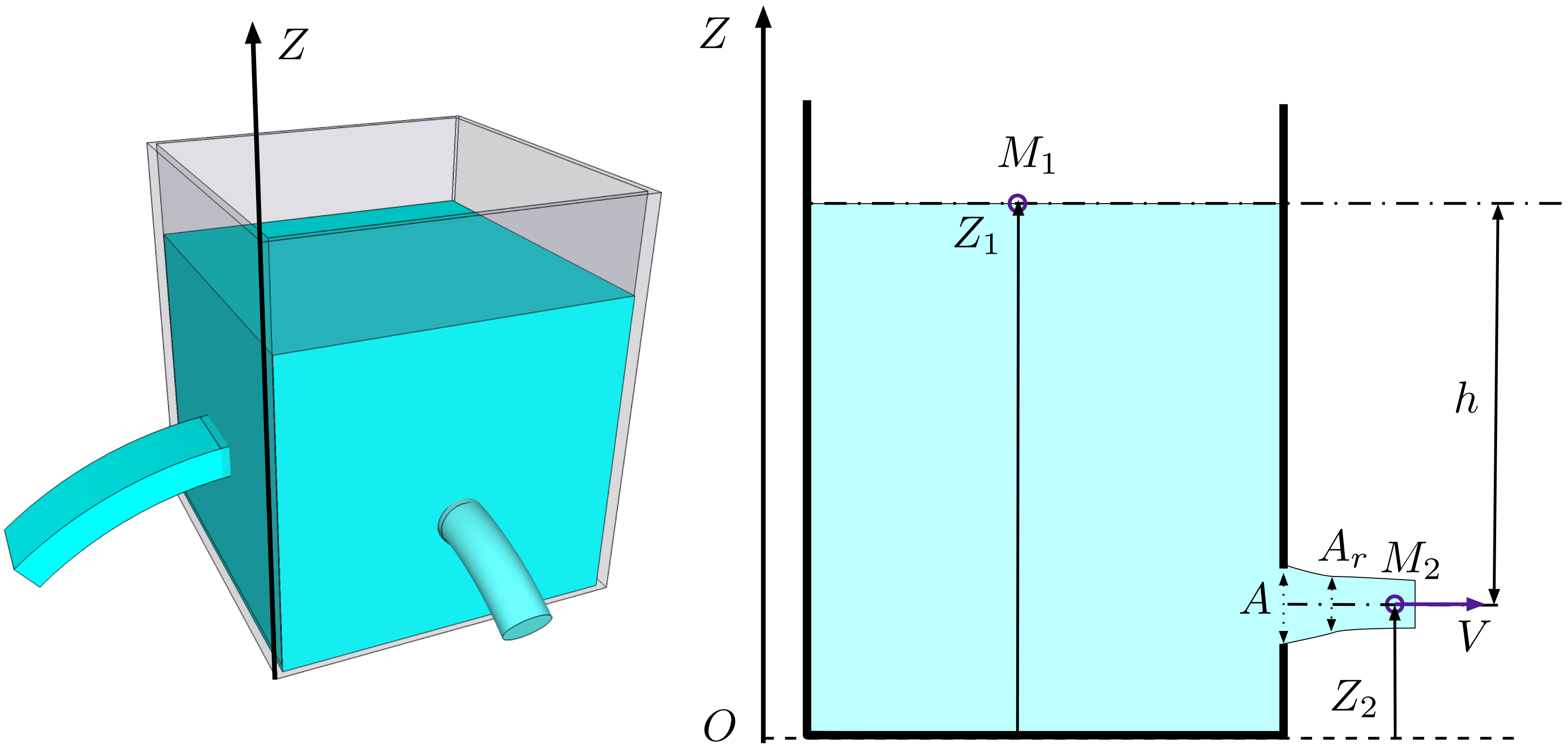






Débit théorique de Toricelli

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



Débit réel à travers un orifice

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

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

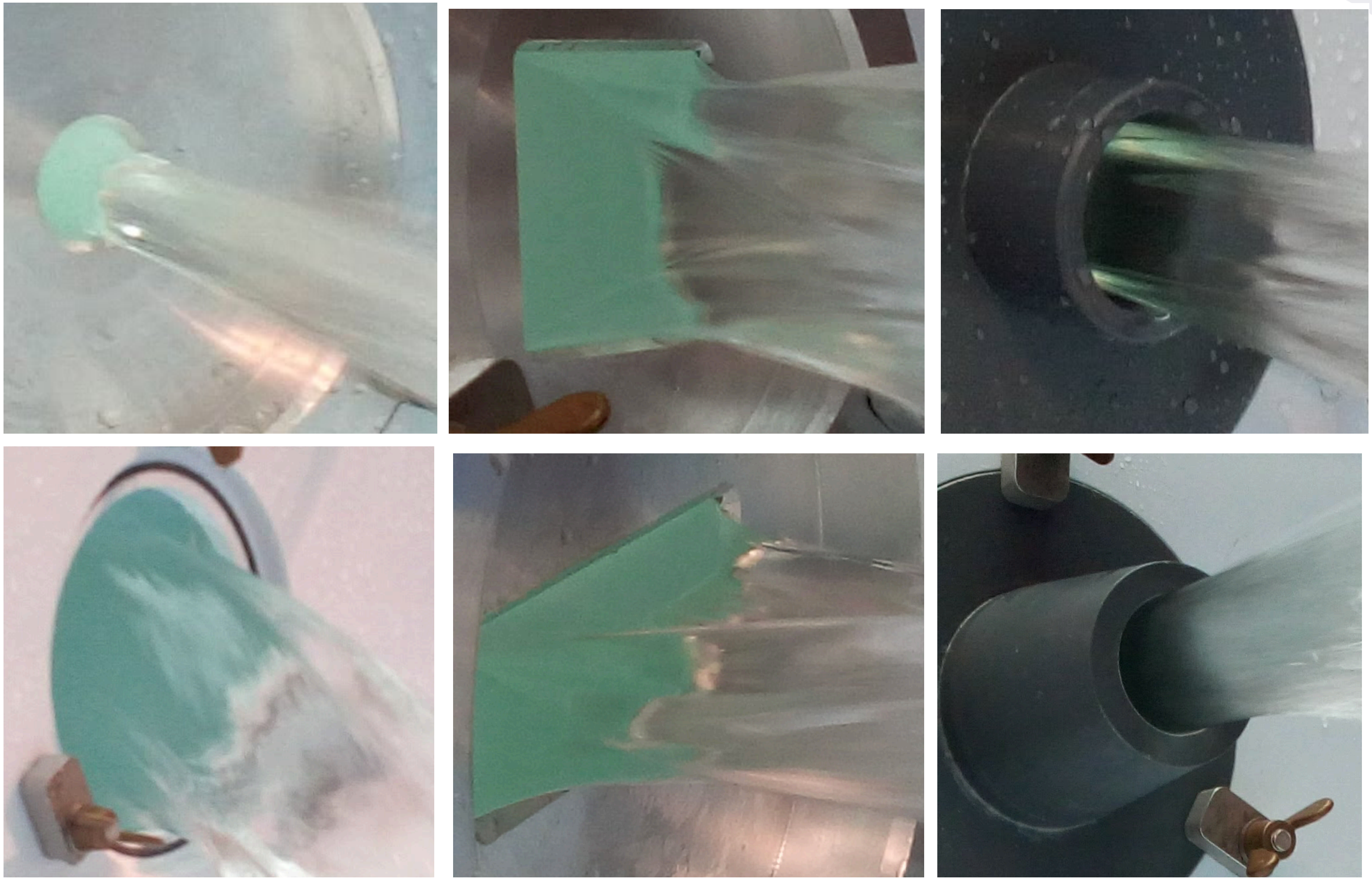
$$\boxed{C_v \sim 0,98}$$

$$\boxed{C_a \sim 0,60}$$

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

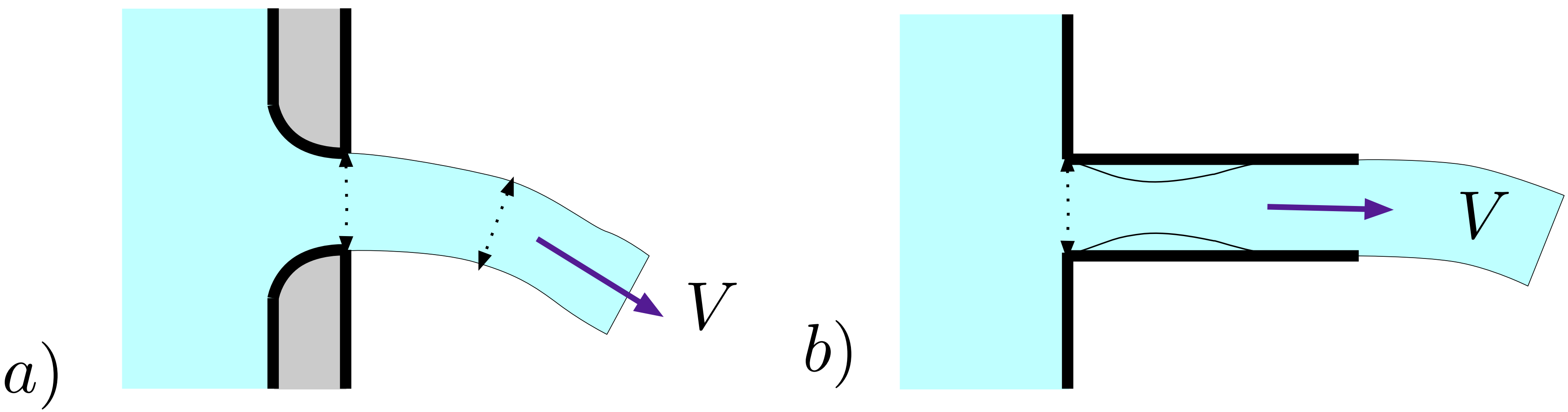
Le coefficient correcteur dépend de la forme des orifices ou ajutages

Orifices et ajutages



Coefficients correcteurs

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



Démonstration dans le cas d'un ajutage :

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

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

$$\boxed{A_{contra} = A} \quad \Longrightarrow \quad \boxed{\mu = C_v = 0,82}$$

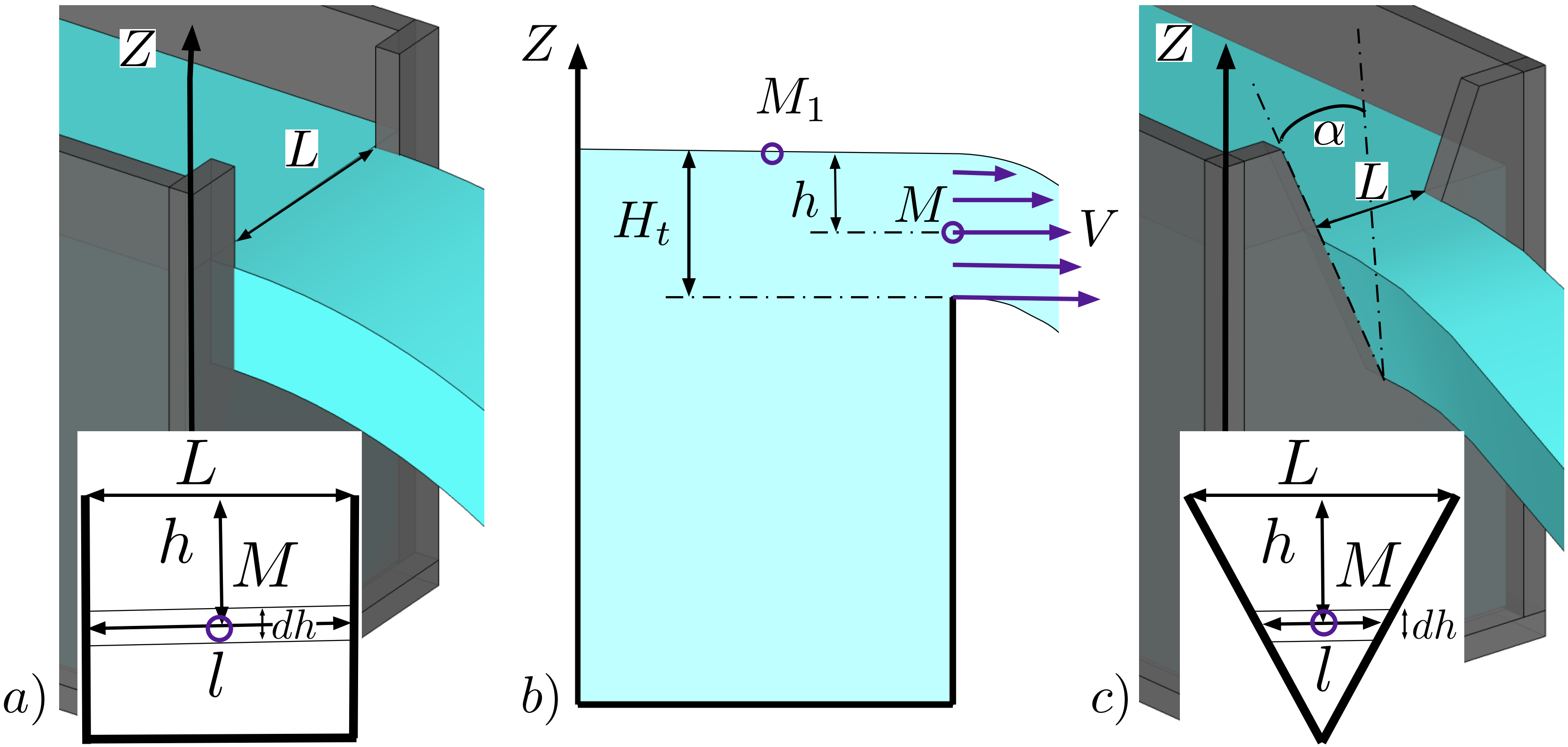
Débit à travers des déversoirs

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

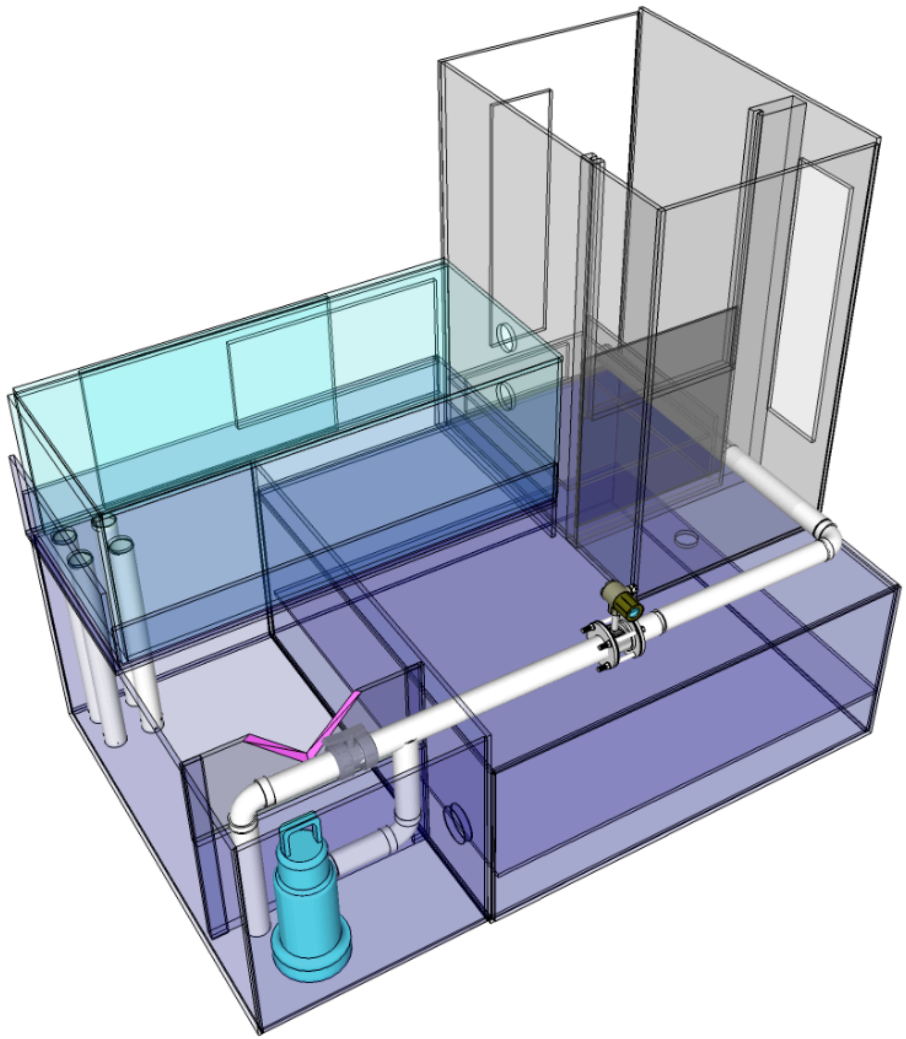
avec $\boxed{\mu_{rect} = 0,415}$

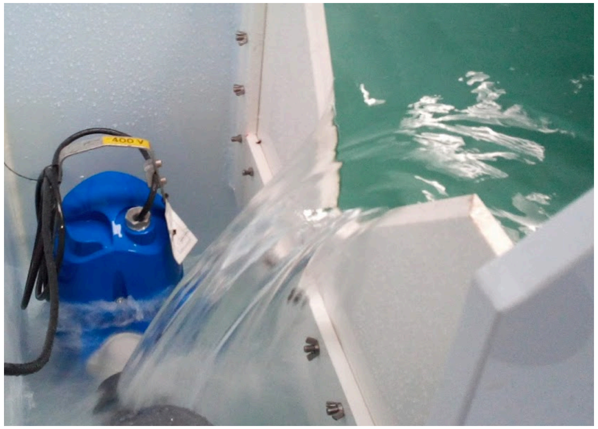
$$\boxed{Q_{tria} = \mu_{tria}\, \frac{8}{15} \tan\alpha \sqrt{2\, g}\, H_t^{5/2}}$$

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



Maquette orifices et ajutages





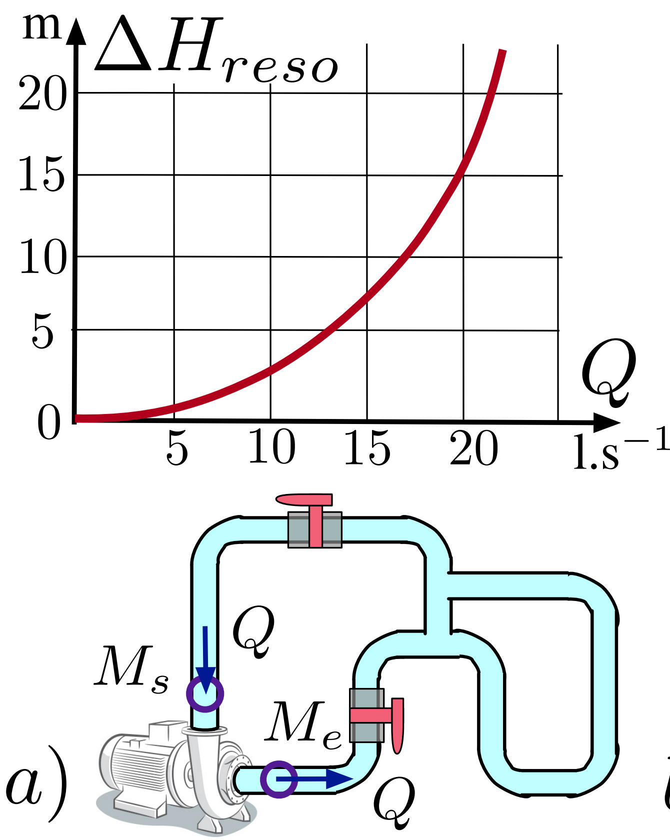
Courbe caractéristique d'un réseau

Réseau en charge

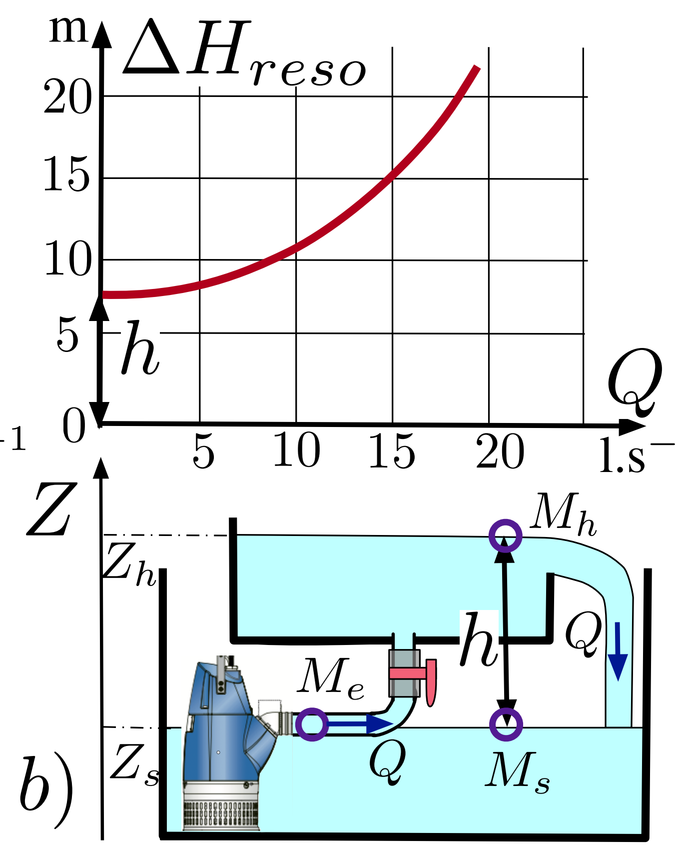
$$\Delta H_{reso} = H_e - H_s$$

Réseau avec surface libre

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



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

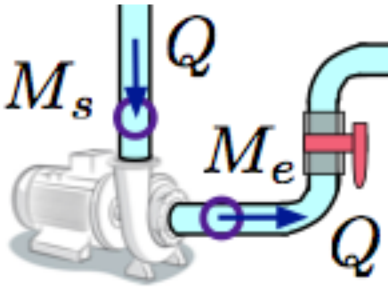


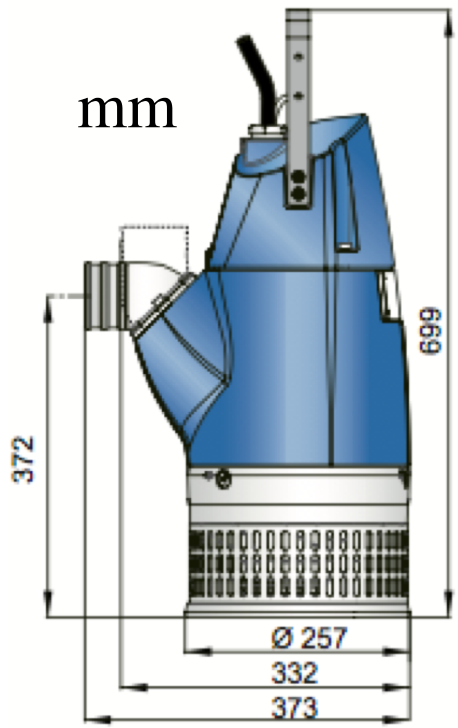
Courbe caractéristique d'une pompe

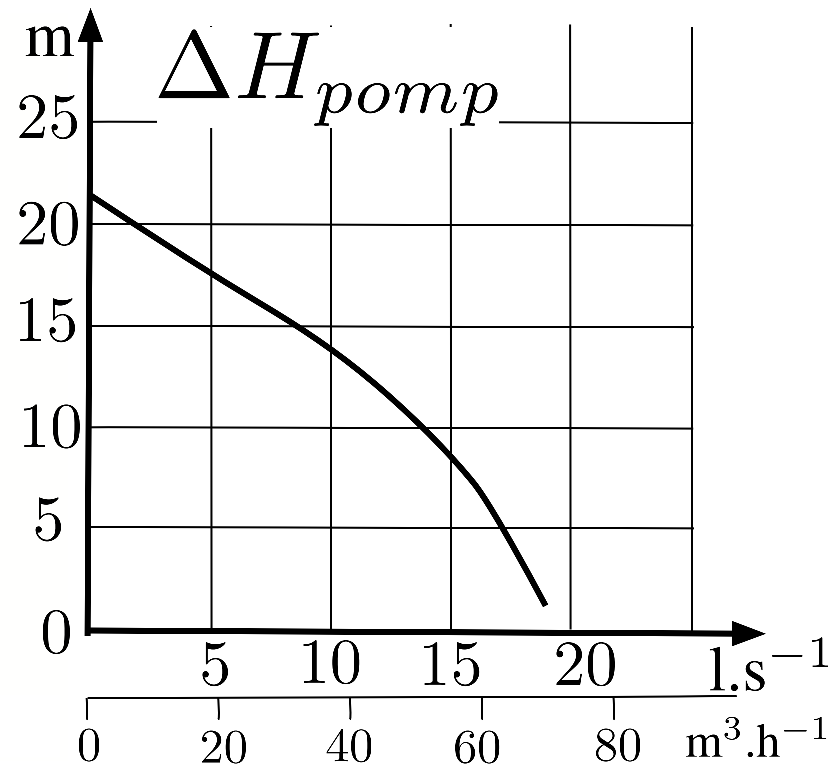
$$\boxed{\Delta H_{pomp}(Q) = H_e - H_s}$$

Hauteur de relèvement :

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

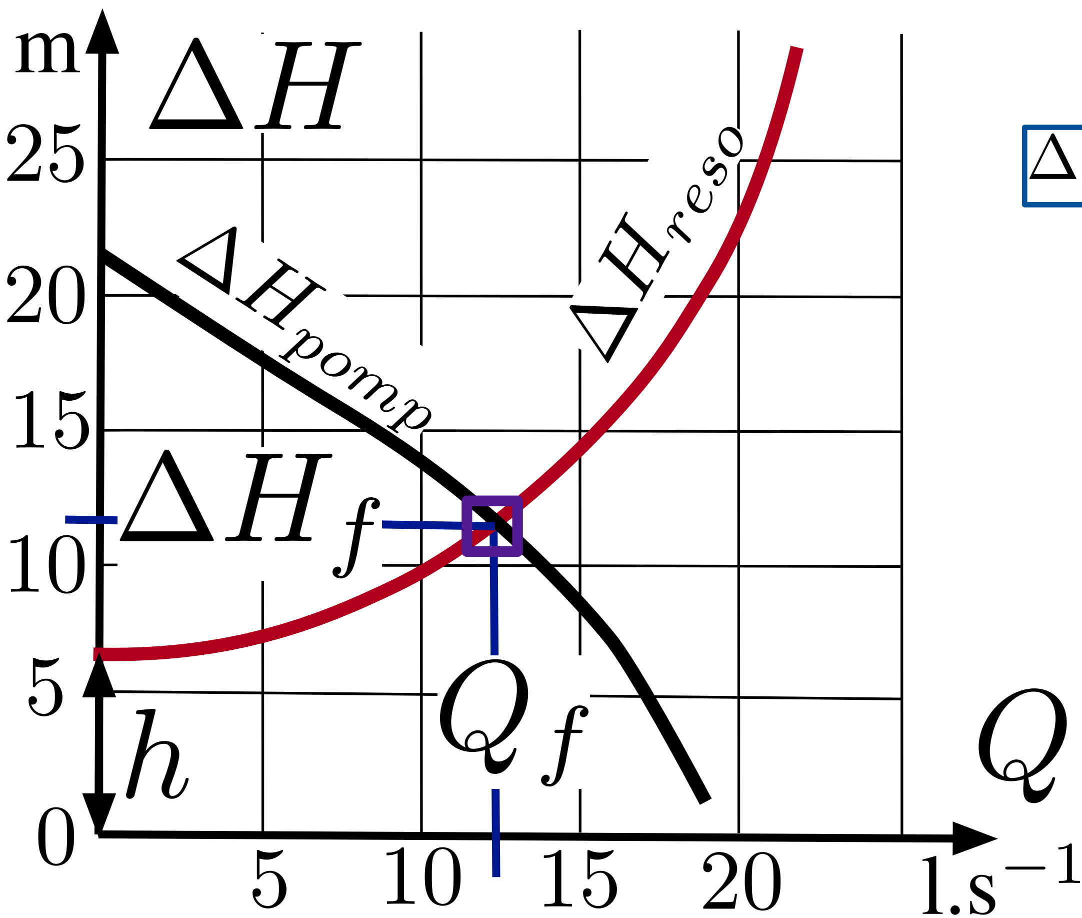




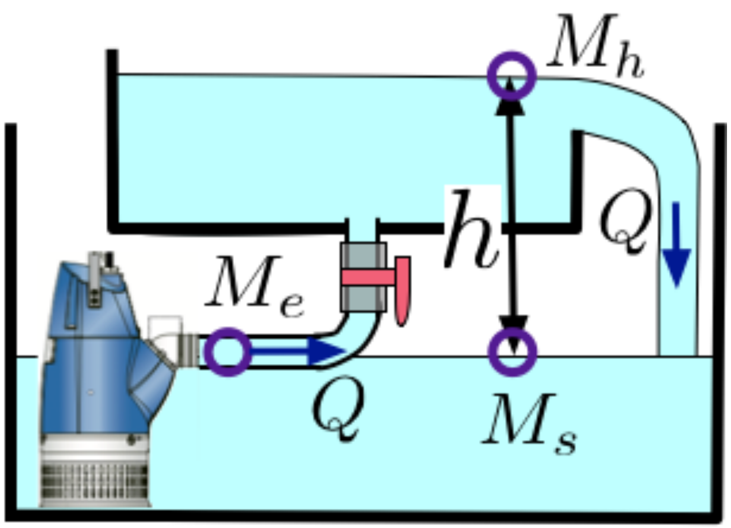


Pompe immergé
de la maquette
orifices et ajutages

Point de fonctionnement



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



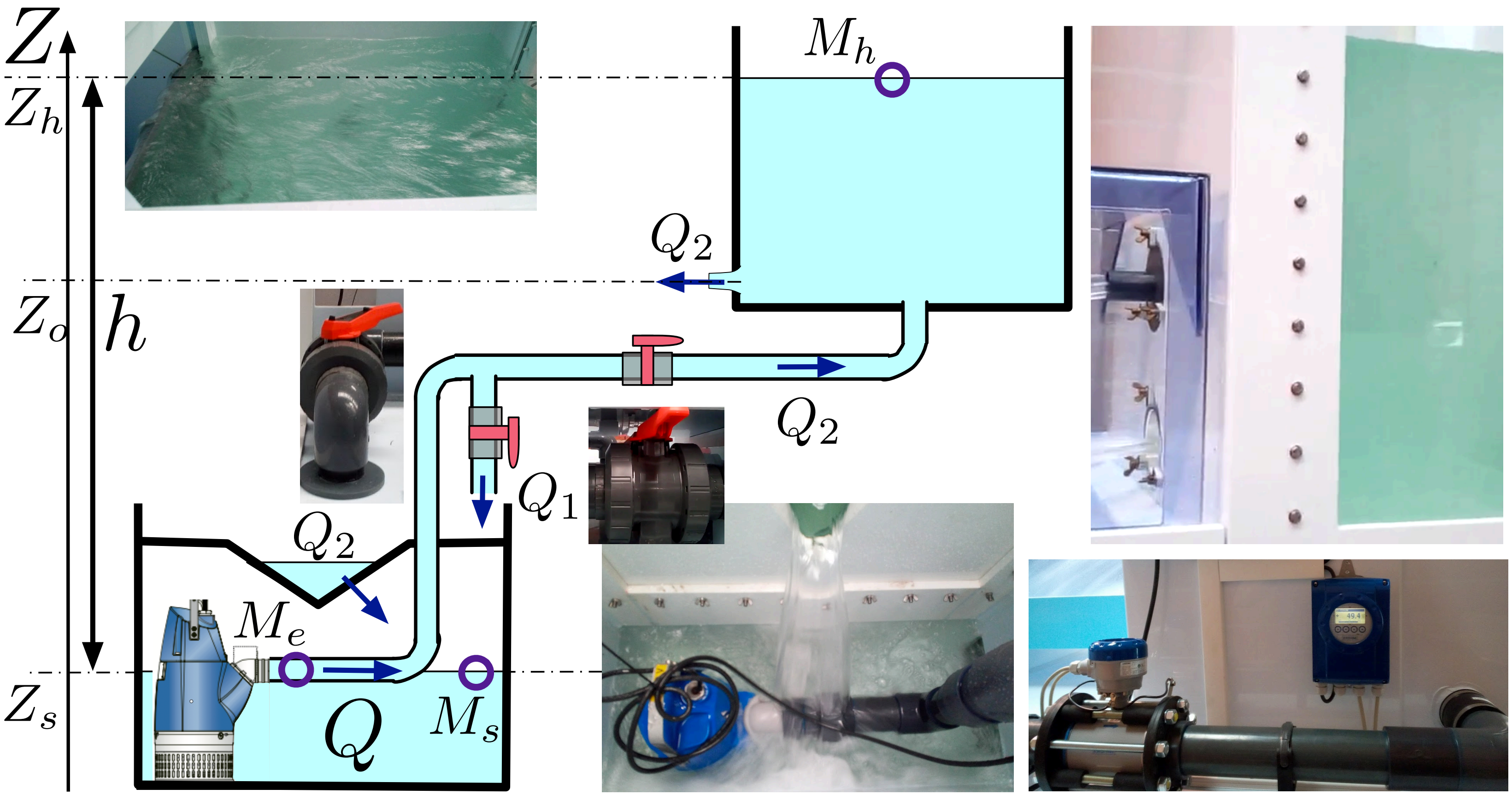
Exemple de réseau

$\boxed{h = Z_h - Z_s = 2 \text{ m}}$ $\boxed{Z_o - Z_s = 1 \text{ m}}$ $\boxed{\alpha = \pi/4}$

Pertes de charges :

$\boxed{\alpha_1 \, Q_1^2}$

$\boxed{\alpha_2 \, Q_2^2}$



Calcul de débits

Modélisation de la pompe :

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

$H_p = 20 \text{ m}$ $Q_m = 20 \text{ l/s}$

Premier cas :

$Q_1 = 0 \Longrightarrow$

$Q_2 = 14 \text{ l/s}$

Calculer : α_2

Deuxième cas :

$Q_2 = 10 \text{ l/s}$

Calculer : α_1