Energy Eq: $h_1 + h_p = h_1 + h_T + h_e$

$h_L = h_m + h_f$

$h_m = k\frac{V^2}{2g}$ → k → table

$h_f = f\frac{V^2}{2g}$ → { laminar → $f = 64/Re$; turbulent → moody → { $f = f(Re)$; $f = f(Re, \frac{k_s}{D})$; $f_{\text{complete turbulence}} = f\frac{k_s}{D}$ }

{ h_T , η_T ; h_p , η_p }

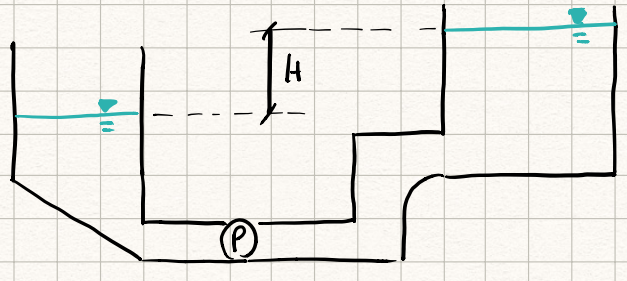
{ EGL ; HGL }

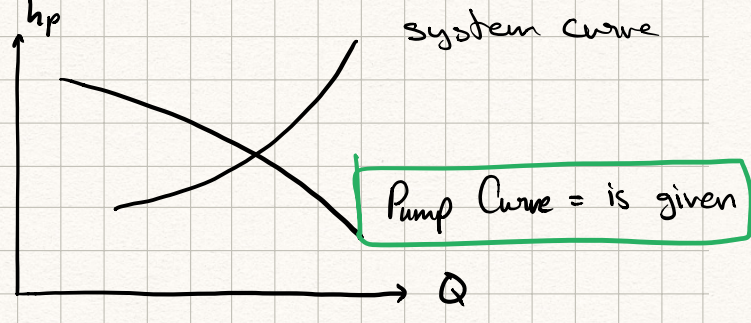
* Questions on the final

$f_{initial} = f$ (titrate ← complet turbulents) { $Q = ?$, $V = 2$; $D = ?$ }

Pump: Design

Q_{design} = is given





En Eq: $h_p = h_2 - h_1 + h_L$

$h_p = H + \left(\Sigma k + \frac{fL}{D}\right)\frac{Q^2}{A^2 2g}$ →

Q	h_p
Q_1	h_{p_1}
⋮	
Q_n	h_{p_n}

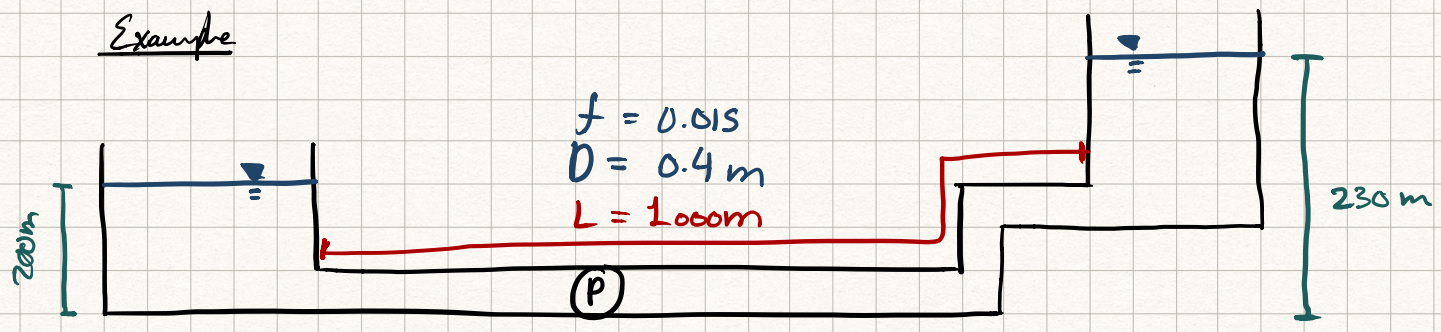
1) - System Curve

2) - Form a table (2/3 Points)

3) - Plot the curve

4) - Q operational

Example



$$1 - h_1 + h_p = h_2 + h_2$$

$$h_p = (230 - 200) + \left(\Sigma k + f\frac{L}{D}\right)\frac{Q^2}{A}$$

$$h_p = 30 + \left(0.5 + 0.35 + 1 + \frac{0.015}{0.4}(1000)\right)\left(\frac{16\,Q^2}{2\pi^2 0.4^4 g}\right)$$

$$h_p = h_p(Q)$$

$$h_p = 30 + 127Q^2$$

2 - Table

Q	hp
0.1	31.27
0.3	41.43