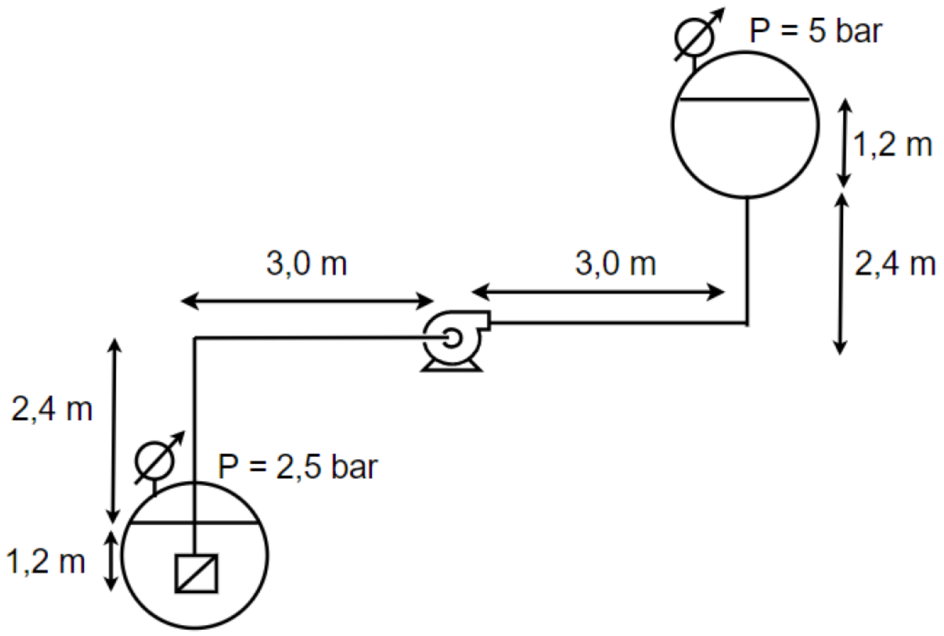
c1. En la figura se muestra un circuito con un tanque que contiene butano (ρ = 560 kg/m^3 y μ = 0,007 mPa.s), la presión de vapor del butano es de 3,5 bara a la temperatura del sistema. La tubería es de acero comercial IPS Sch 40 Φ_N = 1", tiene dos codos de 90° STD y una válvula de pie con filtro de obturador ascendente.



a) Determine el punto de operación.
b) Evalúe si hay riesgo de cavitación. En el caso de que cavite, discuta alternativas para evitarlo.

BEM entre superficies

$$\cancel{\frac{\Delta u^2}{2\alpha g}} + \Delta z + \frac{\Delta P}{\rho g} + \Delta hf = H$$

0

$\varnothing_N = 1''$, Sch 40 $\Big\}$ $D_i = 0{,}0266\,m$

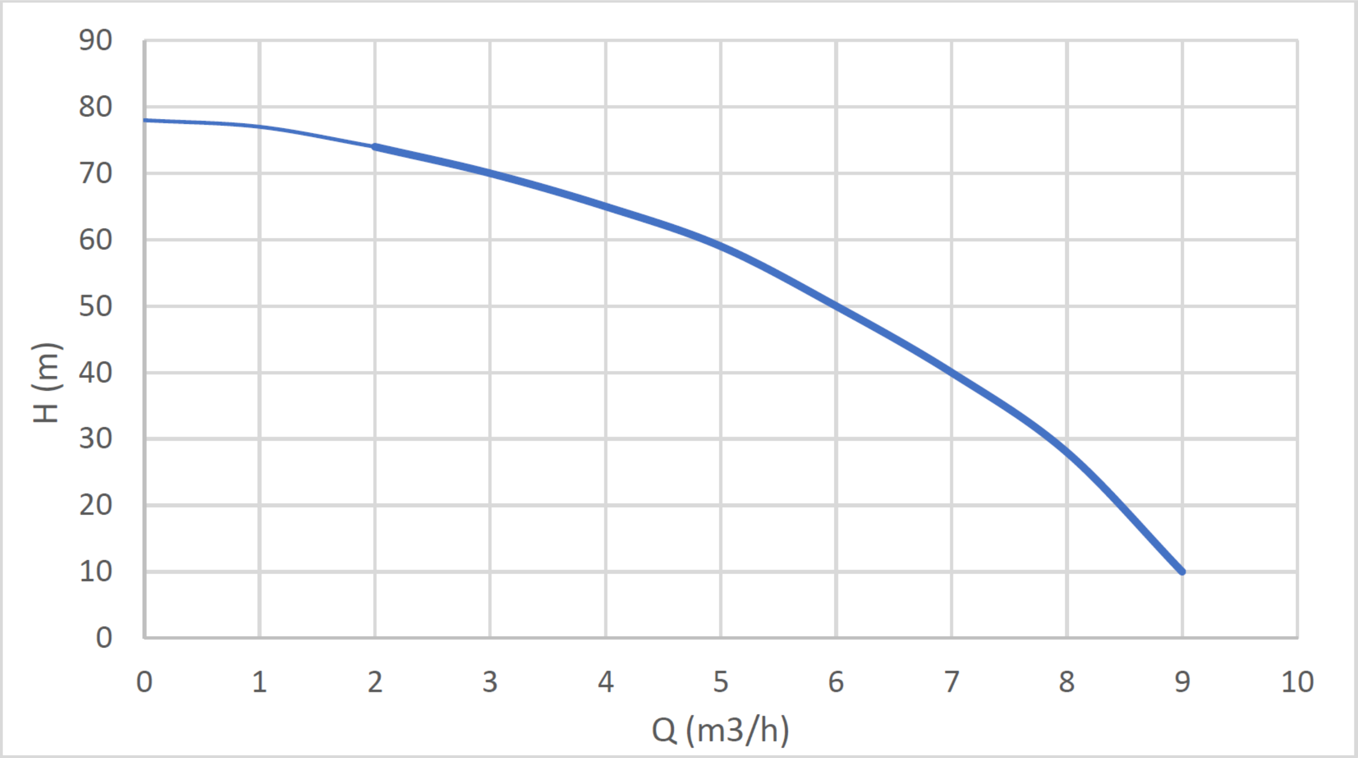
$\frac{\varepsilon}{D} = 0{,}00169$

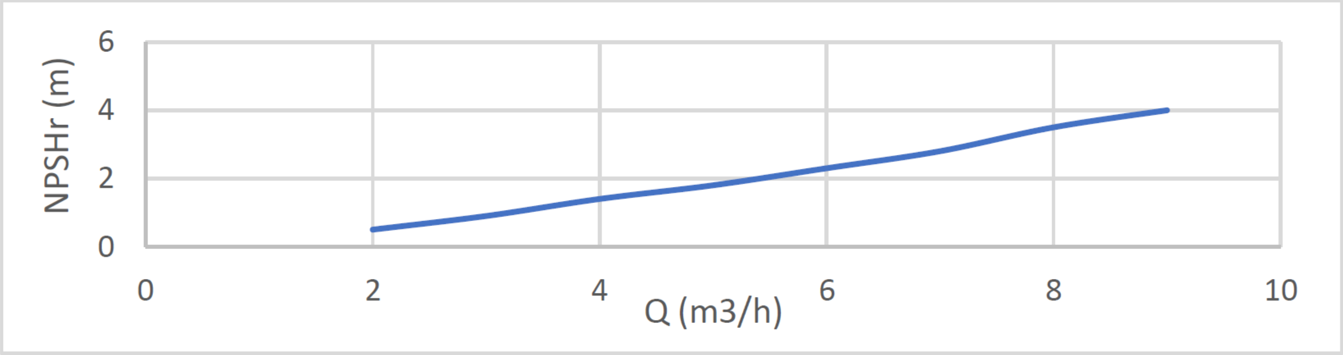
$$2{,}4 + 1{,}2 - (-2{,}4) + \frac{(5-2{,}5)\times 10^5}{560 \times 9{,}8} + \left(f \cdot \frac{L}{D} + \Sigma K\right)\frac{u^2}{2g} = H$$

$$6 + 45{,}5 + \left[f\,\frac{(1{,}2+2{,}4+3+3+2{,}4)}{0{,}0266} + \underset{0{,}023}{\underline{f_T}}\,(420 + 2\times 30) + \overset{K_s}{1}\right]\frac{u^2}{2g} = H$$

$$H \text{ vs } Q\left(m^3/h\right) \rightarrow 51{,}5 + \left(451{,}1 f + 12{,}04\right)\frac{\left[Q\left(m^3/h\right)\right]^2}{2g\left(\frac{\pi}{4}\cdot 0{,}0266^2 \cdot 3600\right)^2} = H$$

El gráfico se ajusta a la expresión analítica: $H\ (m) = -1{,}036\ Q\ (m^3/h)^2 + 2{,}56\ Q\ (m^3/h) + 72{,}19$





Curva del sistema $\rightarrow$ H, Q y f

$$Re = \frac{\rho \cdot u \cdot D}{\mu} = \frac{4 \rho Q\,(m^3/h)}{\mu \pi \cdot D \cdot 3600}$$

C.V BBA:

$$H(m) = -1{,}036\,Q^2 + 2{,}56\,Q + 72{,}19$$

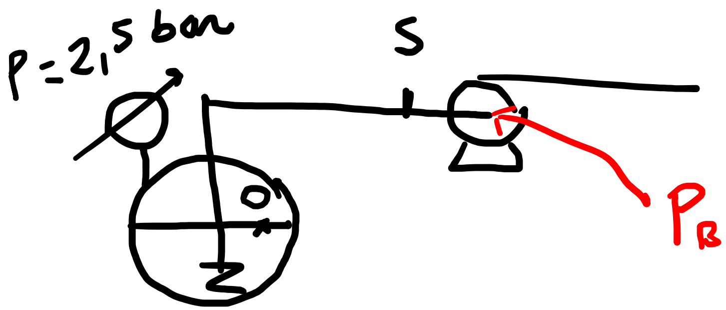
supongo $f = f_T \longrightarrow Q \longrightarrow Re \rightarrow f \rightarrow H \longrightarrow Q$

comparo

Q inicial? $\Rightarrow$ sé que está entre 2 y 9 m^3/h

de $f = f_T \rightarrow Q = 5{,}04\ m^3/h \longrightarrow \left.\begin{aligned} Re &= 5{,}3 \times 10^6 \\ f &= 0{,}026 \end{aligned}\right\} \Rightarrow \left.\begin{aligned} Q &= 4{,}9\ m^3/h \\ H &= 58{,}9 \end{aligned}\right]$ P.O.

b)



$P_B < P_S \rightarrow$ cuánto baja?

NPS H_R

BEM 0 – S

$$\frac{\Delta u^2}{2\alpha g} + \Delta z + \frac{\Delta P}{\rho g} + \Delta hf = 0$$

absoluta!

$(420+30) \times 0{,}023$

$$\underbrace{\frac{u_s^2}{2g} + 2{,}4 + \frac{P_s}{\rho g}}_{h_s} - \frac{3{,}5 \times 10^5}{\rho g} + \left(f \cdot \frac{(1{,}2+2{,}4+3)}{0{,}0266} + \Sigma k\right)\frac{u_s^2}{2g} = 0$$

$$h_s = \frac{u_s^2}{2g} + \frac{P_s}{\rho g} = \frac{3{,}5 \times 10^5}{\rho g} - 2{,}4 - \left(\frac{f(1{,}2+2{,}4+3)}{0{,}0266} + \Sigma k\right)\frac{u_s^2}{2g}$$

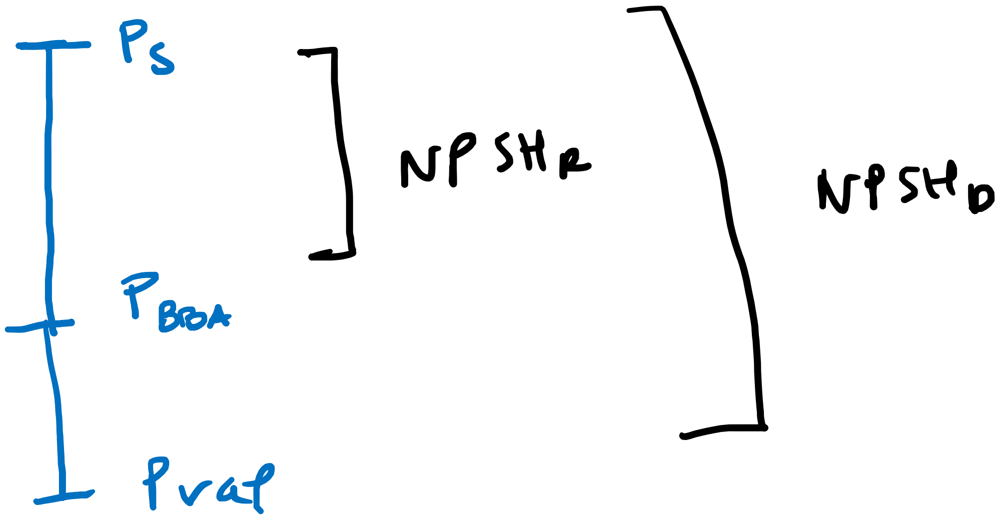
$$h_s = 56{,}2\ m$$

$$h_{vap} = \frac{P_{vap}}{\rho g} = \frac{3{,}5 \times 10^5}{560 \times 9{,}8} = 63{,}8$$

$$NPSH_D = h_s - h_{vap}$$

$$NPSH_D = -7{,}6\ m$$

$NPSH_D < 0$ → cavita ya en la sucaón



$NPSH_R$?

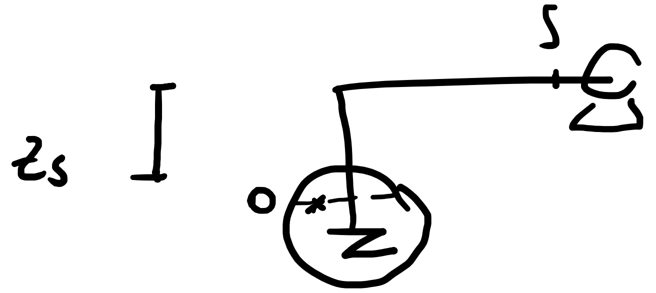
Si $Q = 4{,}9\ m^3/h$ → $NPSH_R \simeq 2m$

Para que no cavite

$$NPSH_D > NPSH_R$$

Alternativas para que no cavite?

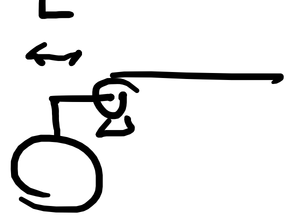
$$NPSH_D = \frac{P_{TK}}{\rho g} - z_s - \Delta hf$$



$h_s - h_{vap}$

Para que $NPSH_D \uparrow$

- * disminuir z_s
- * $\downarrow \Delta hf$
  - $\downarrow Q$ (generalmente es una condición de servicio)
  - $\downarrow \Sigma K$ (x ej con accesorios de menor K)
  - $\downarrow L$ (acercar la bomba)



$$NPSH_D = h_s - \frac{P_{vap}}{\rho g}$$

→ incide la T

↓

es una variable difícil de cambiar