13-2

Purpose

Design system to pump water from water heater to washing system.

Design considerations

- Incompressible fluid
- Isothermic process
- Steady state

Data and Variables

Water at 80°C

$\rho = 971 \frac{kN}{m^3}$

$\gamma = 9.53 \frac{kN}{m^3}$

$\nu = 3.60 \times 10^{-7} \frac{m^2}{s}$

Flow rate

$750 L/min (198 gal/min) = 0.0125 \frac{m^3}{s}$

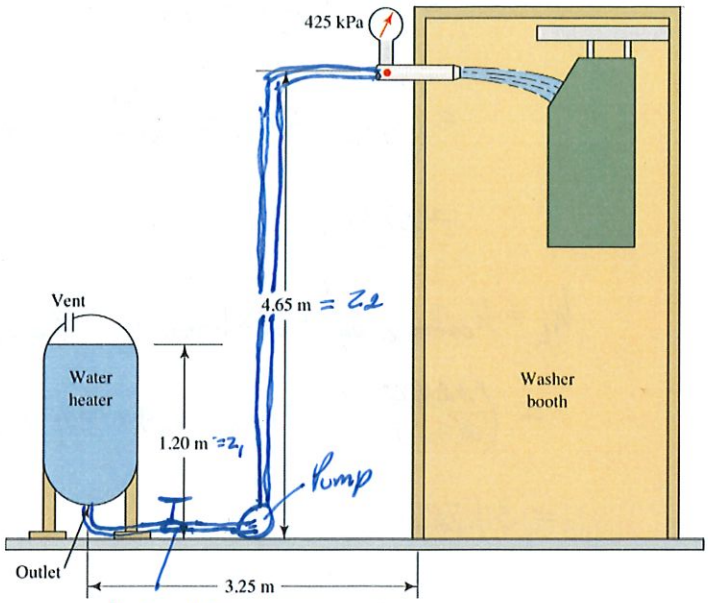
Steel pipe

1 in. sch 40

ID = 26.6 mm

$A = 5.574 \times 10^{-4} m^2$

$\varepsilon = 4.6 \times 10^{-5}$



Angle valve, fully open $\frac{L_e}{D} = 150$

- Information that may be needed to design system

$V = \frac{Q}{A} = \frac{0.0125 m^3/s}{5.574 \times 10^{-4} m^2} = 22.426 \frac{m}{s}$

$N_R = \frac{VD}{\nu} = \frac{22.426 m/s (.0266 m)}{3.60 \times 10^{-7}} = 1657,032$

$\frac{D}{\varepsilon} = \frac{0.0266}{4.6 \times 10^{-5}} = 578.26$

$$f = \frac{0.25}{\left(\log\left(\frac{1}{3.7\left(\frac{D}{\varepsilon}\right)} + \frac{5.74}{N_R^{0.9}}\right)\right)^2}$$

≈ 0.023

$K_{elbow} = 30 f_t = 30(0.022)$

$90° elbow = 0.69$

$K_{valve} = (150) f_t = 150 \times 0.023 = 3.45$

$K_{pump\ assumed} = 2$

$K_{entrance} = 0.5$

- Now I determine the energy losses

$h_L = h_{entrance} + 2h_{elbow} + h_{pipe} + K_{valve}$

$= K_{entrance} \frac{V^2}{2g} + 2 \times K_{elbow} \frac{V^2}{2g} + f \frac{L}{D} \frac{V^2}{2g} + \dots$

$= 0.5 \frac{22.426^2}{2(9.81)} + 2 \times 0.69 \frac{22.426^2}{2(9.81)} + 0.023 \left(\frac{7.9 m}{0.0266 m}\right)\left(\frac{22.426^2}{2(9.81)}\right) + 3.45\left(\frac{22.426^2}{2(9.81)}\right) + \left(\frac{425 \frac{kN}{m^3}}{9.53 \frac{kN}{m^3}} + 4.65\right) - \left(\frac{101,325}{9.53} + 1.20\right)$

$=$

$$h = \left(\frac{P_2}{\rho g} + z_2\right) - \left(\frac{P_1}{\rho g} + z_1\right)$$

$$= \left(\frac{425}{9.53} + 4.65\right) - \left(\frac{101.325}{9.53} + 1.20\right)$$

$$= 37.41\,m$$

$$h_L = k_{entrance}\frac{V^2}{2g} + 2 \times k_{elbow}\frac{V^2}{2g} + k_{valve}\frac{V^2}{2g} + f\left(\frac{L}{D}\right)\left(\frac{V^2}{2g}\right)$$

$$= \left(\frac{22.426^2}{2(9.81)}\right)\left(0.5 + 2 \times 0.69 + 3.45 + 0.023\left(\frac{7.9\,m}{0.026}\right)\right)$$

$$= 311.72\,m$$

$$h_a = 348.72\,m$$

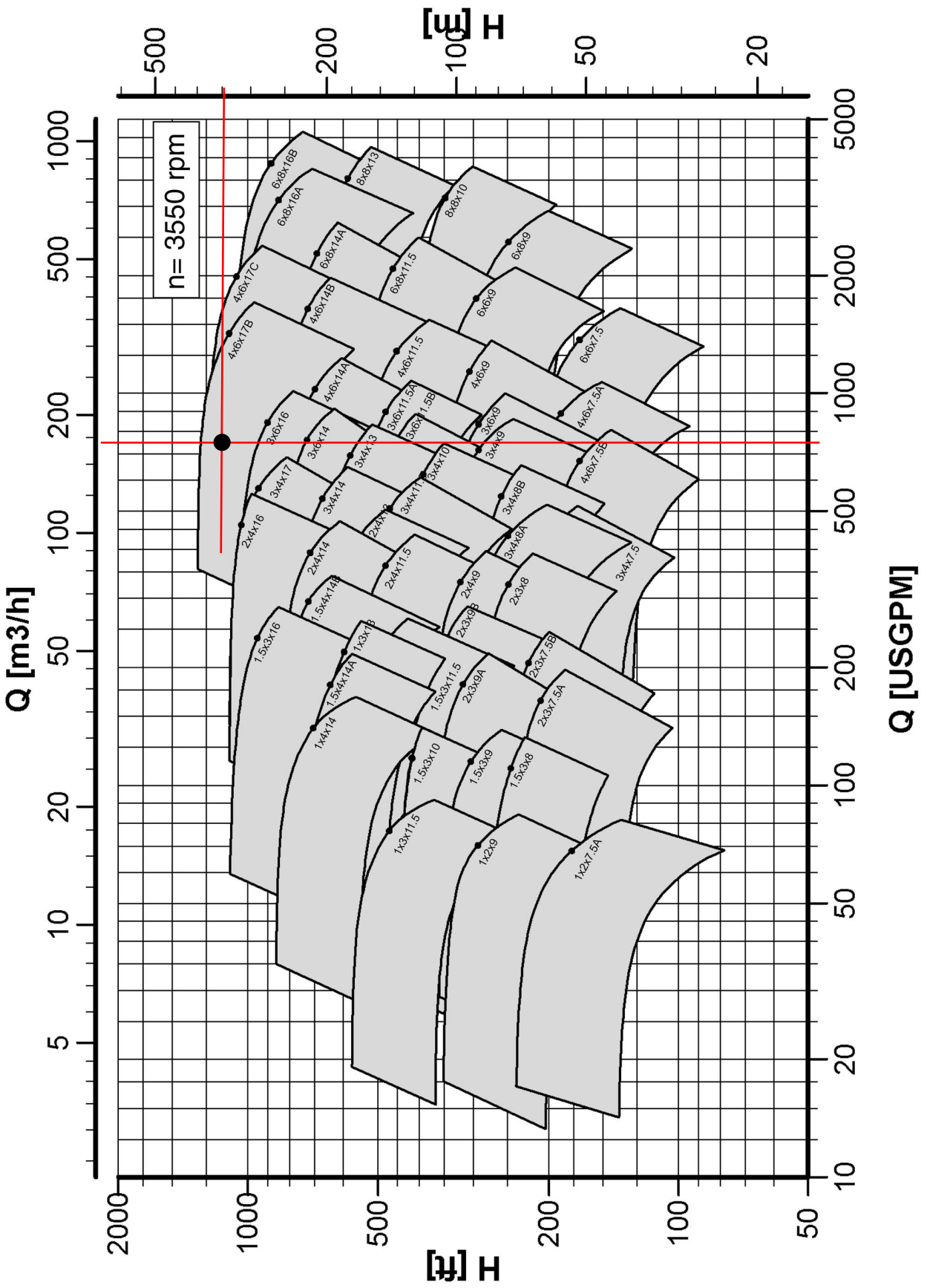
$$Pump = 4 \times 6 \times 178$$

SULZER

CURVES - TYPE OHH

Range of Performances - 60 Hertz 3550 rpm

Series **2.00**	Page
CURVES	60hz
12 February 2002	**E0D**



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