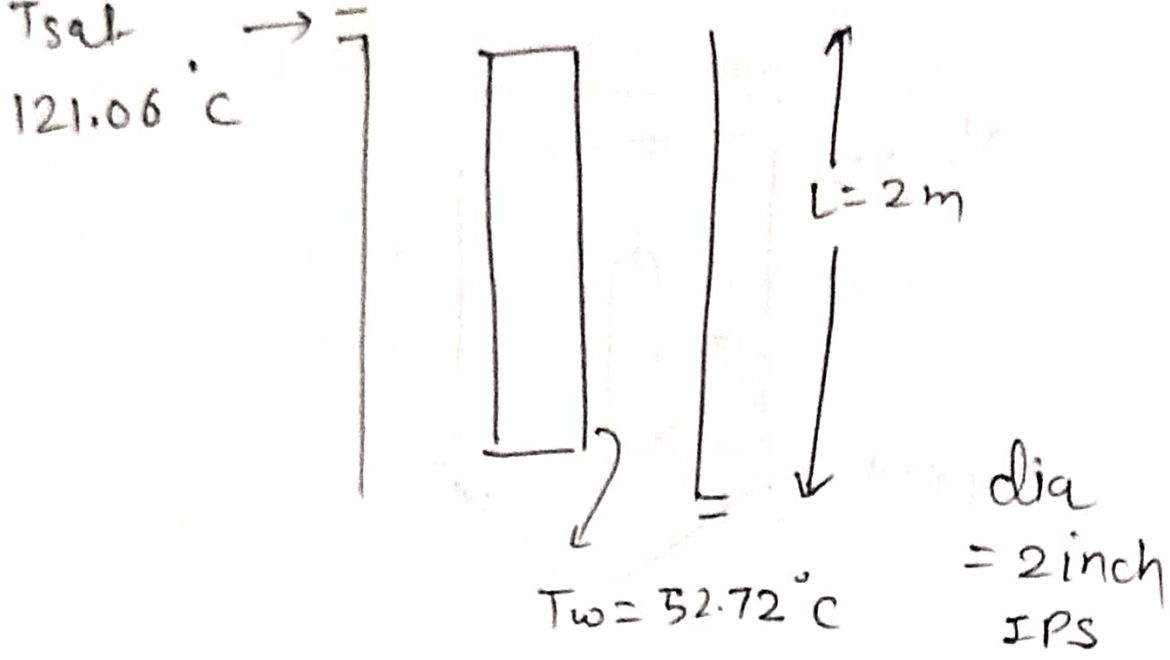


$$T_f = \frac{T_w + T_{sat}}{2} = 86.89\ ^\circ C$$

$$N_{Nu} = \frac{hL}{K_l} = 1.13 \left(\frac{\rho_l (\rho_l - \rho_v) g h_{fg} L^3}{\mu_l K_l \Delta T} \right)^{1/4} \times \text{laminar}$$

h_{fg} at $T_{sat} = 121.06\ ^\circ C$

all others are at $T_f = 86.89\ ^\circ C$

$\rho_l = 967.57 \quad kg/m^3$

$\rho_v = 0.377 \quad kg/m^3$

$\mu_l = 3.26 \times 10^{-4} \quad Pa.s$

$\mu_w = 5.23 \times 10^{-4} \quad Pa.s$
(52.12°C)

$C_{pl} = 1.884 \quad \frac{kJ}{kg\,K}$

$K_l = 0.671$

$$N_{Re} = \frac{4m_s}{\pi D \mu_L} = \frac{4 \times 6289.53}{3600 \times \pi \times 5.08 \times 10^{-2} \times 3.26 \times 10^{-4}}$$

$$= 134321.18$$

Turbulent

$$N_{Nu} = 0.027 (N_{Re})^{0.8} N_{Pr}^{1/3} \left(\frac{\mu_b}{\mu_w}\right)^{0.14}$$

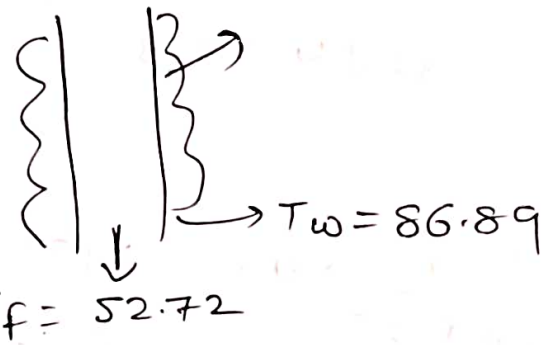
$$N_{Pr} = \frac{\mu_L C_{pL}}{k_L} = \frac{3.26 \times 10^{-4} \times 1.884 \times 10^{3}}{0.671} = 0.915$$

$$\frac{h_L \times 5.08 \times 10^{-2}}{0.671} = 0.027 (134321.18)^{0.8} (0.915)^{\frac{1}{3}} \left(\frac{3.26}{5.23}\right)^{0.14}$$

$$h_L = \frac{0.671}{5.08 \times 10^{-2}} \times 0.027 \times 310.696$$

$$h_D = 4103.84$$

for inner :→



$$N_{Re} = \frac{4\dot{m}_p}{\pi D \mu_L} = \frac{4 \times 24}{\pi \times 36 \times 5.08 \times 10^{-2} \times 766 \times 10^{-2}}$$

$$= 2181.36$$

μ_L

↘ 52.72

Temp	50 %
50	8.31
60	5.93

$$\frac{2.57}{10} = \frac{\mu_L - 8.31}{5.93 - 8.31}$$

$$\mu_L = 7.66 \times 10^{-3} \text{ Pa.S}$$

$K_L \Rightarrow$

	50 %	$\frac{W}{m.K}$
50	0.467	
60	0.477	0.469

Nw

↘ 86.89

$= 2.88 \times 10^{-3}$

52.72 ⇒ ~~0.4458~~

$$\frac{h_L \times 5.08 \times 10^{-2}}{0.469} = 0.027 \times (2181.36)^{0.8} \times Pr^{1/3} \left(\frac{7.66}{2.88}\right)^{0.14}$$

$$Pr = \frac{\mu_L C_{pL}}{K_L} = \frac{7.66 \times 10^{-3} \times 2911.85}{0.469} = 47.56$$

$C_{pL} \Rightarrow$ =

50 %	
50	~~2973~~ 2889
60	~~3019~~ 2973

$C_{pL} = 2911.55$

$$\frac{2.72}{10} \times (0.477 - 0.467) + 0.467 = 0.469$$

h_L

$$= \frac{0.469}{5.08 \times 10^{-2}} \times 0.027 \times (2181.36)^{0.8} \times (47.56)^{1/3} \left(\frac{7.66}{2.88}\right)^{0.14}$$

$h_L = 485.53$

$$\frac{h_i h_o}{h_i + h_o} = U = \frac{485.53 \times 4103.84}{485.53 + 4103.84}$$

$$U = 434.16$$

$$\Rightarrow \quad q = U A \Delta T$$

$$\Rightarrow \quad \frac{6289.53}{36} \times 2199.61 \times 10 = 434.16 \; A \; 68.34$$

$\uparrow$

86.89 (TF)

$$\left\{ \frac{1.06}{5} \times (2188.5 - 2202.6) + 2202.6 \right\} = 2199.61$$

$$\boxed{A = 129.52 \; m^2}$$

$$N = \frac{129.52}{\pi \times 5.08 \times 10^{-2} \times 2} = 405.8$$

$$\approx 406 \text{ pipes}$$