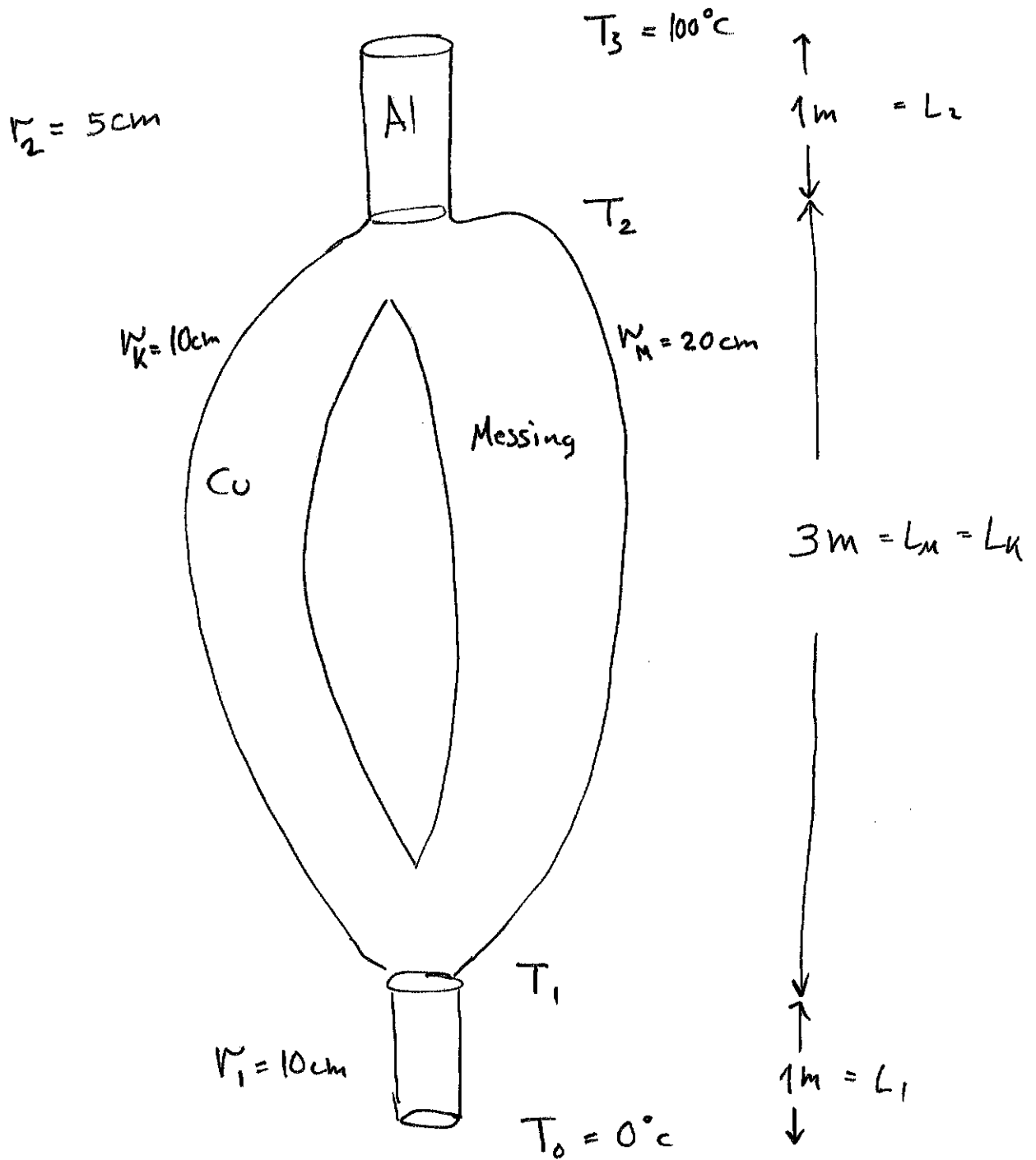


Oppgave laget av studentene.



Hva er varmestrømmen?

Varmelednings koeffisientene er

$$k_{Al} = 205 \text{ W/mK}, \quad k_{Cu} = 385 \text{ W/mK}$$

$$k_M = 109 \text{ W/mK}$$

$$\phi_1 = \frac{k_{A1} \cdot A_1}{L_1} \cdot (T_1 - T_0)$$

$$\phi_2 = \frac{k_{A1} \cdot A_2}{L_2} (T_3 - T_2)$$

$$\phi_M = \frac{k_M \cdot A_M}{L_M} (T_2 - T_1)$$

$$\phi_K = \frac{k_K \cdot A_K}{L_K} (T_2 - T_1)$$

$$\phi = \phi_M + \phi_K$$

$$= \left(\frac{k_M \cdot A_M}{L_M} + \frac{k_K \cdot A_K}{L_K} \right) \cdot (T_2 - T_1)$$

$$\phi = \phi_1 = \phi_M + \phi_K = \phi_2$$

$$T_3 - T_0 = 100^\circ\text{C}$$

$$= (T_3 - T_2) + (T_2 - T_1) + (T_1 - T_0)$$

$$\phi \left(\frac{k_{A1} \cdot A_2}{L_2} \right)^{-1} + \phi \left(\frac{k_M \cdot A_M}{L_M} + \frac{k_K \cdot A_K}{L_K} \right)^{-1} + \phi \left(\frac{k_{A1} \cdot A_1}{L_1} \right)^{-1}$$

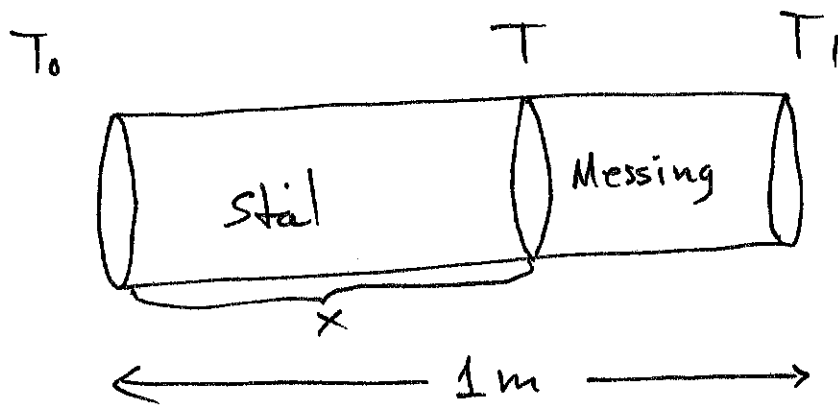
$$100^\circ\text{C} = \phi \left[\left(\frac{k_{A1} \cdot A_2}{L_2} \right)^{-1} + \left(\frac{k_M \cdot A_M}{L_M} + \frac{k_K \cdot A_K}{L_K} \right)^{-1} + \left(\frac{k_{A1} \cdot A_1}{L_1} \right)^{-1} \right]$$

$$\phi = 100\text{K} \left[\left(\frac{k_{A1} \cdot r_2^2}{L_2} \right)^{-1} + \left(\frac{k_M \cdot r_M^2}{L_M} + \frac{k_K \cdot r_K^2}{L_K} \right)^{-1} + \left(\frac{k_{A1} \cdot r_1^2}{L_1} \right)^{-1} \right] \cdot \pi$$

$$= 100\text{K} \left[(0.4878 + 0.3654 + 1.9512) \text{K} \cdot \text{W}^{-1} \right]^{-1} \cdot \pi$$

$$= \underline{112\text{W}}$$

3



Hvor lang må ståldelen av stanga
 være for at temperaturen i overgangen
 mellom stål og messing er $T = \frac{T_0 + T_1}{2}$.

($T_0 = 300\text{ K}$, $T = 400\text{ K}$, $T_1 = 500\text{ K}$)

Termisk konduktivitet

A er tverrsnittsareal

Stål $k_s = 50.2\text{ W/mK}$

Messing $k_m = 109\text{ W/mK}$

Varmestrømmen gjennom stål: $\Phi_s = (T - T_0) k_s \cdot A / x$

Messing: $\Phi_m = (T_1 - T) k_m \cdot A / (1 - x)$

$\Phi_s = \Phi_m$ T er $\frac{T_1 + T_0}{2}$ så $T - T_0 = \frac{T_1 - T_0}{2}$ like
 $T_1 - T = \frac{T_1 - T_0}{2}$

$$\left(\frac{T_1 - T_0}{2}\right) \cdot k_s \cdot A / x = \left(\frac{T_1 - T_0}{2}\right) k_m \cdot A / (1 - x)$$

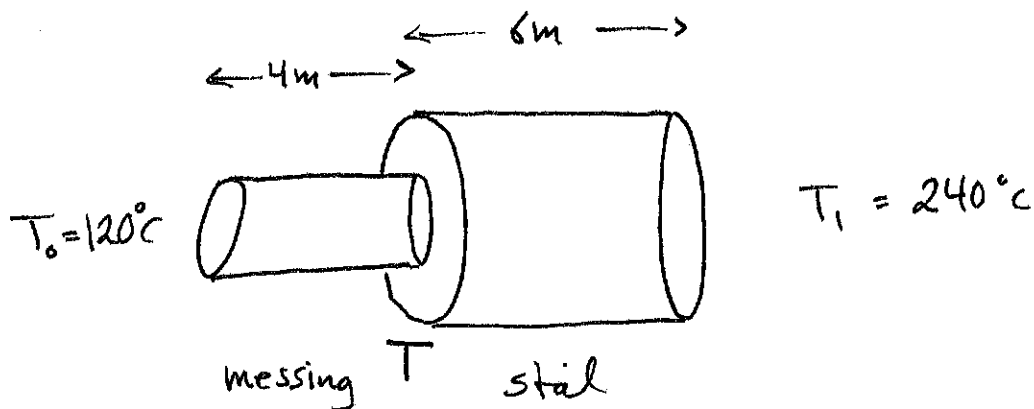
$$\frac{k_s}{x} = \frac{k_m}{1 - x}$$

$$(1 - x) k_s = x \cdot k_m, \quad k_s - x \cdot k_s = x \cdot k_m$$

$$k_s = x (k_s + k_m)$$

Så lengden $x = \frac{k_s}{k_s + k_m} = \underline{\underline{31.5\text{ cm}}}$

4



radius: $r_m = 10\text{cm}$

$r_s = 20\text{cm}$

$k_m = 109\text{W/mK}$

$k_s = 50.2\text{W/mK}$

a) Hva er varmestrommen

b) Hva er temperaturen i overgangen mellom messing og stål stengene?

$u_m = k_m / 4\text{m}$

$u_s = k_s / 6\text{m}$

$\phi_m = (T - T_0) u_m \cdot \pi \cdot r_m^2$

$\phi_s = (T_1 - T) u_s \pi \cdot r_s^2$

$\phi = \phi_m = \phi_s$

$\frac{\phi}{u_m \pi \cdot r_m^2} + \frac{\phi}{u_s \pi r_s^2} = (T - T_0) + (T_1 - T) = T_1 - T_0 = 120^\circ\text{C} = 120\text{K}$

a) $\phi = (T_1 - T_0) \left[\frac{1}{u_m r_m^2} + \frac{1}{u_s r_s^2} \right]^{-1} \pi$ setter inn

$= \underline{266\text{W}}$

b) $T = T_0 + \frac{\phi}{u_m \cdot \pi r_m^2} = \underline{197.8^\circ\text{C}}$