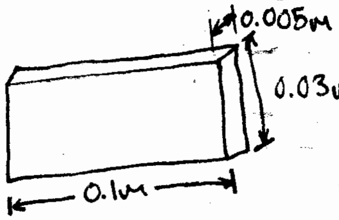
10/20/16 | MENG 263 | Assignment 5 | Isaac Coolumbia | ①

Question 1)

$k = 180\,W/m\cdot k$
$\dot{Q} = 1kW$
$T_\infty = 20°C$
$h = 15\,W/m^2\cdot C$
$T_b = 120°C$



$A_{fin} = 2(0.03m)(0.1m + (0.5)(0.005m)) = \boxed{6.15\times10^{-3}m^2}$

$A_{unfin} = (0.005m)(0.03m) = \boxed{1.5\times10^{-4}m^2}$

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*a) $\xi = (L + \tfrac{1}{2}t)\sqrt{h/kt} = (0.1m + \tfrac{1}{2}(0.005m))\sqrt{\frac{15W/m^2\cdot C}{0.005m(180W/m\cdot k)}} = 0.418$, $\therefore \boxed{\eta = 0.83}$

$\dot{Q} = \eta h A_{fin}(T_b - T_\infty) = 0.83(15W/m^2\cdot C)(6.15\times10^{-3}m^2)(100°C) = \boxed{7.66W}$ (per fin)

need 1000W, $\therefore$ #fins $= \frac{1000W}{7.66W} = \boxed{131\text{ fins}}$ ← #fins (a)

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*b) $\dot{Q}_{total} = \dot{Q}_{surface} + \dot{Q}_{fins} = hA_{surface}(T_b - T_\infty) + 131(7.66W)$
$= 15W/m^2(\tfrac{\pi}{4}(0.25m)^2 + \pi(0.25m)(0.03m)) - 131(0.005m)(0.03m))(100°C)$
$+1003.64$

$= \boxed{1083.1W}$ ← $\dot{Q}_{total}$

Question 2)

$\dot{Q} = \frac{\Delta T}{R_{total}} = \frac{35°C}{25°C/W} = \boxed{1.4W}$ ← $\dot{Q}$

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Question 3)

$\dot{Q} = 40W$ a) $T_b = 90°C$, $T_\infty = 20°C$, $\dot{Q} = \frac{\Delta T}{R}$, $R = \frac{\Delta T}{\dot{Q}} = \frac{70°C}{40W} = \boxed{1.75°C/W}$ ← R_a

$\therefore$ case R must be below 1.75°C/W for sufficient heat transfer, we can use:

→ HS5030 (horizontal/vertical)
→ HS6071 (vertical)
→ HS6115 (horizontal/vertical)

← Heat Sinks (a)

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b) $T_b = 60°C$, $T_\infty = 20°C$ $R = \frac{40°C}{40W} = \boxed{1°C/W}$ — R_b

$\therefore$ case R must be below 1°C/W for sufficient heat transfer, we can use:

→ HS5030 (vertical) ← Heat Sink (b)

Question 4)

a) $\dot{Q}_{total} = \dot{Q}_{outside} + \dot{Q}_{dirt} = \frac{\Delta T_1}{R_1} + k\Delta T(S_1 + S_2)$

$R_1 = \frac{1}{hA} = \frac{1}{(22W/m^2\cdot C)(\pi(5\times10^{-2}m)(2m))} = 0.145\,°C/W$

$S_1 = \frac{2\pi L}{\ln(4L/D)} = \frac{2\pi(3m)}{\ln(4(3m)/5\times10^{-2}m)} = 3.44m$

$S_2 = \frac{2\pi L}{\ln(4L/D)} = \frac{2\pi(20m)}{\ln(4(3m)/5\times10^{-2}m)} = 22.93m$

$\therefore \dot{Q}_{total} = \frac{72°C}{0.145°C/W} + 1.5W/m\cdot C(80°C)(3.44m + 22.93m) = \boxed{3.66kW}$ ← $\dot{Q}_t$

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b) $\dot{Q} = \dot{m}C_p\Delta T = \rho VAC_p\Delta T$

$\therefore \Delta T = \frac{\dot{Q}}{\rho VAC_p} = \frac{3.66kW}{(971kg/m^3)(1.5m/s)(\tfrac{\pi}{4}(5\times10^{-2}m)^2)(4.198\,kJ/kg\cdot k)}$

$\boxed{= 0.305°C}$ ← ΔT

* The device is far too small, diameter would have to be 250 mm for the amount of fins necessary