LEZIONE 7

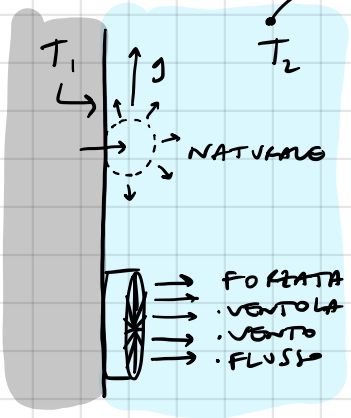
21/10/21

CONDUZIONE

FLUSSO DI CALORE $\left(\frac{W}{m^2 s}\right)$

$$J = \frac{k}{d}(T_1 - T_2) = h(T_1 - T_2)$$

CONVEZIONE



TEMPERATURA DEL FLUIDO LONTANO DALLA PARETE

$$J = h(T_1 - T_2)$$

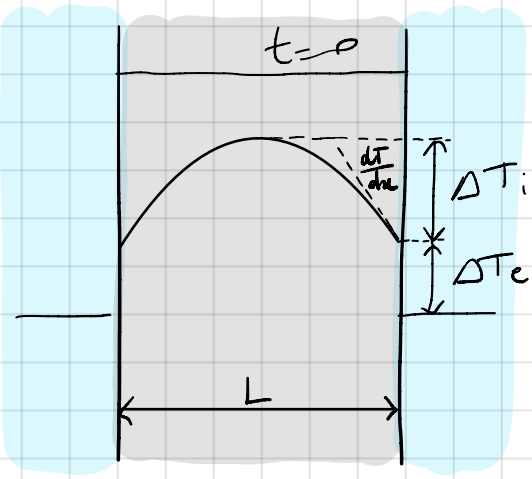
ARIA $\quad h \sim \frac{5\ W}{m^2 K} \div \frac{30\ W}{m^2 K}$

↑ VENTO 6 m/s

ACQUA $\quad h \sim 750\ \frac{W}{m^2 K}$

(SENZA AGITARE)

LEGGE DEL RAFFREDDAMENTO DI NEWTON

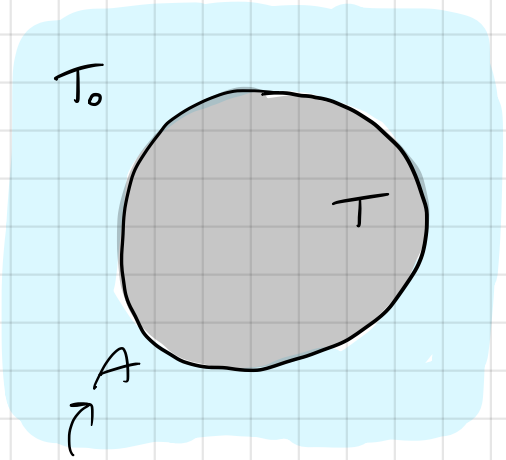


$$-k\frac{dT}{dx} = h\,\Delta T_e$$

$$k\frac{\Delta T_i}{L} \qquad \frac{\Delta T_i}{\Delta T_e} = \frac{hL}{k} = Bi$$

BIOT NUMBER

$Bi \ll 1 \Rightarrow$ POSSO CONSIDERARE T INTERNA UNIFORME



$Bi \ll 1$

T INTERNA UNIFORME

$$\dot{Q} = h(T - T_0)A$$

$$\delta Q = -\dot{Q}\,dt = C\,dT$$

δQ: CALORE ASSORBITO IN UN TEMPO dt

C: CAPACITÀ TERMICA

$$\frac{dT}{dt} = -\frac{\dot{Q}}{C} = -\frac{hA}{C}(T - T_0) \qquad \Delta T = T - T_0$$

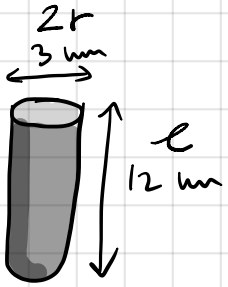
$$\frac{d\Delta T}{dt} = -\frac{\Delta T}{\tau} \qquad \tau = \frac{C}{hA}$$

$$\Delta T = \Delta T(0)\, e^{-\frac{t}{\tau}}$$

$$C = mc \sim L^3$$

$$A \sim L^2 \qquad \tau \sim L$$

ES. TERMOMETRO MERCURIO



$\rho = 1.3\ 10^4\ kg/m^3$

$c = 140\ J/kg\,K$

$k = 8.3\ \frac{W}{mK}$

$$Bi = \frac{hL}{k} = \frac{750\ W/m^2K \cdot 8.3\ mm}{8.3\ W/mK} \cdot 10^{-3} \cdot \frac{1}{2} \sim 0.1$$

$$\tau = \frac{C}{hA} = \frac{\rho c \pi r^2 e}{h 2\pi r e} = \frac{\rho c r}{2h} = \frac{1.3\ 10^4\ kg/m^3 \cdot 140\ J/kg\,K \cdot 1.5 \cdot 10^{-3}\ m}{2 \cdot 750\ W/m^2K}$$

$$= 1.8\ s$$

$A \sim 2\pi r e$

ESERCIZIO

5 PM

$m = 70\ kg$

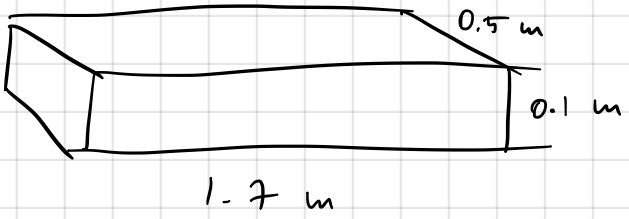
$T_a = 20°C$ AMBIENTE

$T_1 = 25°C$ CADAVERE

ORA OMICIDIO ?

$$T_1 - T_a = (T_0 - T_a)\, e^{-\frac{t}{\tau}}$$

$$\tau = \frac{mc}{hA}$$



$A \sim 2\ m^2$ $\quad h = 5\ \frac{W}{m^2 K}$

$C = 3.5\ J/gK$

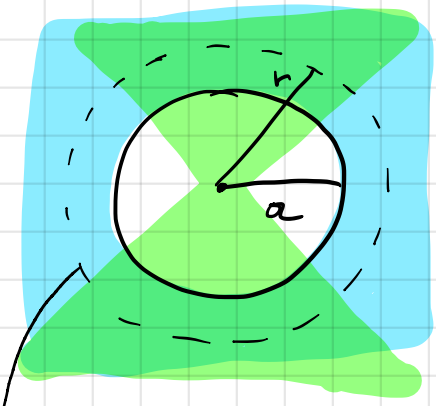
$$\tau = \frac{70\,10^3\ \cancel{g}\ 3.5\ \cancel{J}\ s\ \cancel{m^2}\ \cancel{K}}{5\ \cancel{J}\quad \cancel{0K}\quad 2\ \cancel{m^2}} = 24500\ s = 6.8\ h$$

$T_0 = 36.5°C$

$$t = \tau \ln \frac{T_0 - T_a}{T_1 - T_a} = 6.8\ h \ln \frac{16.5}{5} = 8.1\ h$$

ORA OMICIDIO $\quad 5_{PM} - 8\ h = 9\ AM$

ESERCIZIO



MICROSFERA DI VETRO $a = 1\,\mu m$

IN ACQUA $K = 0.6\ W/mK$ $T_0 = 20°C$

INTRAPPOLATA OTTICAMENTE

DA UN FASCIO LASER $P = 1\ mW$

CALCOLARE LA TEMP. SUPERFICIALE

DELLA SFERA QUANDO ASSORBE 1% DELLA

POTENZA INCIDENTE

$T(r)$ $\qquad \vec{J} = -K\vec{\nabla}T = -K\frac{dT}{dr}\hat{r}$

$$\dot{Q} = \int \vec{J}\cdot d\vec{S} = -K\frac{dT}{dr}\,4\pi r^2 = \text{COSTANTE}$$

$$\frac{dT}{dr} = -\frac{\dot{Q}}{K\,4\pi r^2} \qquad T(r) = \frac{\dot{Q}}{K\,4\pi r} + c$$

$$T(a) = c = T_0 \qquad \dot{Q} = \alpha P$$

$$T(a) - T_0 = \frac{\alpha P}{K\,4\pi a} = \frac{10^{-2}\,10^{-3}\,W\,m\,K}{0.6\,W\,12\,10^{-6}\,m} = 1.3\ K$$