

DEITURAK/APELLIDOS:

IZENA/NOMBRE:

**TITULAZIOA/TITULACIÓN:**

N.A.N./D.N.I:

IKASTURTEA/CURSO:

DATA/FECHA:

**IRAKASGAIA/ASIGNATURA:**

[illegible]

2018-05-31

$$T_{air} = 18^{\circ}\text{C}$$

a) Temperatur bawaketa ekuadial

$$\frac{1}{r^n} \cdot \frac{d}{dr} \left( r^n \cdot \frac{dT}{dr} \right) + \frac{\dot{e}_{gen}^0}{k} = 0 \Rightarrow n=1 \text{ (Zylinder)}$$

$$\frac{1}{r} \frac{d}{dr} \left( r \cdot \frac{dT}{dr} \right) = 0 \rightarrow \int \frac{d}{dr} \left( r \cdot \frac{dT}{dr} \right) = \int 0 \rightarrow$$

$$\int r \cdot \frac{dT}{dr} = C_1 \rightarrow \int \frac{dT}{dr} = \frac{C_1}{r} \rightarrow \underline{T(r) = C_1 \ln r + C_2}$$

b) Muzalde baldintza  $\rightarrow T =$  zehatza eta konbektibitatez muzalde baldintza


$$c) \dot{Q}_{\text{Kond}} = \dot{Q}_{\text{Kont}} \Rightarrow -k \cdot \frac{dT}{dr} = h \cdot (T_r - 18) \rightarrow \left[ 0,035 \cdot \frac{dT}{dr} = 10,5 (C_1 \ln(0,25) + C_2 - 18) \right]$$

T zeharia  $\rightarrow \boxed{80 = C_1 \cdot \ln(0,2) + C_2} \rightarrow C_2 = 80 - C_1 \ln(0,2)$

$$-0,086 \cdot \frac{C_1}{0,25} = 10,5 (C_2 \cdot \ln(0,25) + 80 - C_1 \cdot \ln(0,2) - 13) \rightarrow -0,144 C_1 = 10,5 (62 + 0,223 C_1) \rightarrow -0,144 C_1 = 651 + 2,34 C_1 \rightarrow \underline{C_1 = -262} \quad C_2 = 341$$

$$T(r) = -262 \cdot \ln r - 341 \quad \text{d) } T(0,25) = 22,2^\circ\text{C}$$

2. GAIA

Dra:  $p = 971,8 \frac{\text{kg}}{\text{m}^3}$ ;  $C_p = 4197$ ;  $\alpha = 0,14 \cdot 10^{-6}$ ;  $k = 0,67$   
 ↳ zeitbat energie traktor da  $T = -k$  berdindig arte? 

4. GAIA

g) Q?  $Q = m \cdot c_p \cdot \Delta T = \rho \cdot V \cdot c_p \cdot \Delta T = 971,8 \cdot (\pi \cdot 0,2^2 \cdot 0,95) \cdot 4197 \cdot (80-18) = 3,09 \cdot 10^7 \text{ W}$

f)  $\epsilon$ ? (sequenzen)

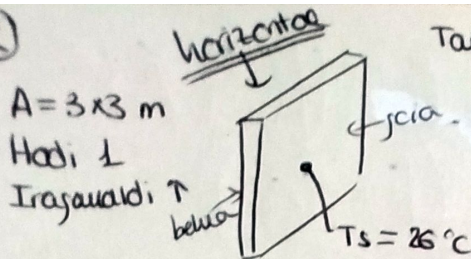
Tavla  $\rightarrow Q_{\max} \rightarrow Q_{\max} = Q \rightarrow 1$   
 $B_i = \frac{h r_c}{\lambda} = \frac{10,5 \cdot 9,2}{0,67} = 3,134 \Rightarrow Bi^2 \tau = 15$

$$Bi^2 \cdot z = \frac{h^2 \alpha t}{K^2}$$

$$15 = \frac{10,5^2 \cdot 0,14 \cdot 10^{-6} \cdot t}{0,672} \rightarrow t = \frac{14.663,5}{436.248,8} = 121,2 \text{ h}$$



2



a)  $Nu$ ? b)  $h$ ? c)  $Q$ ?

$$\dot{Q} = h \cdot A \cdot (T_s - T_{air})$$

$Nu$  lortzeko

$$Ra_L = \frac{g \beta (T_s - T_\infty) L^3}{\nu^2} \cdot Pr$$

$$T_f = \frac{26 + 18}{2} = 22$$

$$\beta = \frac{1}{22 + 273} = 0,0034$$

$$L_c = \frac{A_s}{P} = \frac{9}{12} = 0,75 \text{ m}$$

$$Ra_L = \frac{9,8 \cdot 0,0034 \cdot (26 - 18) \cdot 0,75^3 \cdot 0,7304}{(1,5344 \cdot 10^{-5})^2} = 3,49 \cdot 10^8$$

$K(22^\circ\text{C})$

$$\frac{25 - 20}{0,02551 - 0,02514} = \frac{25 - 22}{0,02551 - K} \rightarrow K = 0,0253$$

$Pr(22^\circ\text{C})$

$$\frac{25 - 20}{0,7296 - 0,7304} = \frac{25 - 22}{0,7296 - Pr} \rightarrow Pr = 0,7304$$

$\nu(22^\circ\text{C})$

$$\frac{25 - 20}{(1,562 - 1,516) \cdot 10^{-5}} = \frac{25 - 22}{1,562 \cdot 10^{-5} - \nu} \rightarrow \nu = 1,5344 \cdot 10^{-5}$$

9 GAIA

Goiko aldean

$$Nu = 0,15 \cdot Ra^{1/3} \rightarrow Nu_1 = 105,6 \rightarrow Nu = \frac{h \cdot L}{K} \rightarrow h_1 = 3,56 \frac{\text{W}}{\text{m}^2 \cdot ^\circ\text{C}} \rightarrow \dot{Q} = 256,3 \text{ W}$$

Behoko aldean

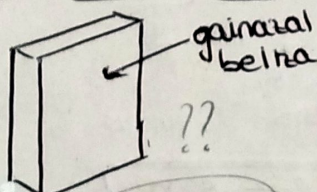
$$Nu = 0,27 \cdot Ra^{1/4} \rightarrow Nu_2 = 36,9 \rightarrow h = \frac{36,9 \cdot 0,0253}{0,75} = 1,245 \frac{\text{W}}{\text{m}^2 \cdot ^\circ\text{C}} \rightarrow \dot{Q} = 89,64 \text{ W}$$

Bertikalean  $\Rightarrow L_c = 3 \text{ m}$

d) e) f) ...

$$\dot{Q} = 164,016 \text{ W}$$

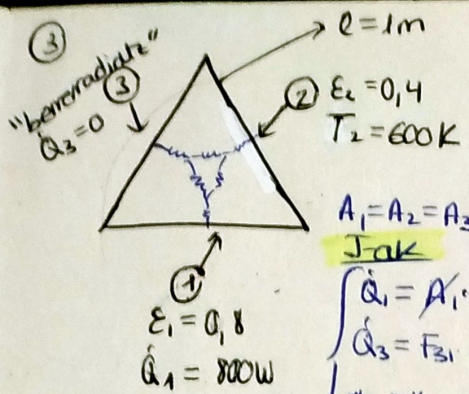
9. GAIA



13. GAIA

EO





- 1) F-ak
- 2) J-ak
- 3)  $\dot{Q}_{12}, \dots$
- 4)  $T_1, T_3?$

$F_{11} = 0$	$F_{12} = 0,5$	$F_{13} = 0,5$
$F_{21} = 0,5$	$F_{22} = 0$	$F_{23} = 0,5$
$F_{31} = 0,5$	$F_{32} = 0,5$	$F_{33} = 0$

$A_1 F_{12} = A_2 F_{21}$   
**Fak**

$A_1 = A_2 = A_3$   
**J-ak**

$$\begin{cases} \dot{Q}_1 = A_1 \cdot F_{12} \cdot (J_1 - J_2) + A_1 F_{13} \cdot (J_1 - J_3) \\ \dot{Q}_3 = F_{31} \cdot (J_3 - J_1) + F_{32} \cdot (J_3 - J_2) \\ 0 = T_2^4 = J_2 + \frac{1 - \epsilon_2}{\epsilon_2} \cdot [F_{23} \cdot (J_2 - J_3) + F_{21} \cdot (J_2 - J_1)] \end{cases} \Rightarrow \begin{cases} 800 = 0,5(J_1 - J_2) + 0,5(J_1 - J_3) \\ 0 = 0,5(J_3 - J_1) + 0,5(J_3 - J_2) \\ 5,67 \cdot 10^{-8} \cdot 600^4 = J_2 + \frac{1 - 0,4}{0,4} \cdot [0,5(J_2 - J_3) + 0,5(J_2 - J_1)] \end{cases}$$

$$\begin{aligned} \rightarrow \begin{cases} 1600 = 2J_1 - J_2 - J_3 \rightarrow 1600 = 4J_3 - J_2 - J_2 - J_3 \rightarrow 1600 = 3J_3 - 2J_2 \rightarrow 533,3 = J_3 - J_2 \quad \textcircled{J_3 = 533,3 + J_2} \\ 0 = 2J_3 - J_1 - J_2 \rightarrow J_3 = \frac{J_1 + J_2}{2} \rightarrow J_1 = 2J_3 - J_2 \rightarrow J_1 = 1066,67 + 2J_2 - J_2 \rightarrow J_1 = 1066,67 + J_2 \\ 7348,32 = J_2 + 1,5 \cdot 0,5 [2J_2 - J_1 - J_3] \rightarrow 7348,32 = 2,5J_2 - 0,75J_1 - 0,75J_3 \quad \textcircled{*} \end{cases} \end{aligned}$$

$\textcircled{*} \rightarrow 7348,32 = 2,5J_2 - 0,75(1066,67 + J_2) - 0,75(533,3 + J_2) \rightarrow$

$7348,32 = 2,5J_2 - 800 - 0,75J_2 - 400 - 0,75J_2 \rightarrow \boxed{J_2 = 8548,32} \quad \boxed{J_1 = 9615} \quad \boxed{J_3 = 9081,65}$

**Qak**  
 $\rightarrow \begin{matrix} \dot{Q}_{12} \\ \dot{Q}_{13} \end{matrix}$   
 ??

$$\begin{aligned} \dot{Q}_{12} &= \frac{J_1 - J_2}{R_{12}} & \dot{Q}_{13} &= \frac{J_1 - J_3}{R_{13}} & R_{12} &= \frac{1}{F_{12} \cdot A_1} & R_{13} &= \frac{1}{F_{13} \cdot A_1} \end{aligned}$$

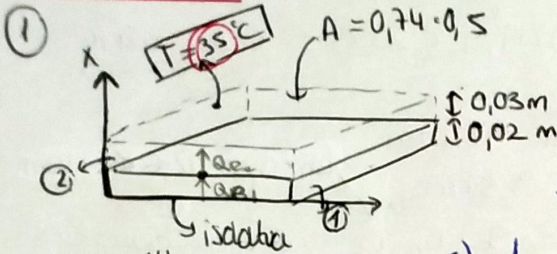
**3, T₁**

$$\dot{Q} = \frac{E_b - J}{R_s} \quad R_s = \frac{1 - \epsilon}{A \cdot \epsilon}$$

$$800 = \frac{5,67 \cdot 10^{-8} \cdot T_1^4 - 9615}{\frac{1 - 0,8}{10,8}} \rightarrow T_1 = \underline{\underline{645K}}$$



2015-05-18



a)  $q_{\text{kontakman?}}$

c)  $T(r) = \dots$  (plautra)

e)  $T_{\text{kontakman?}}$

b)  $\dot{e}_{\text{gen?}}$

d)  $T(r) \dots$  (sandwichak)

$$q_{\text{erap}} = -k \cdot A \cdot \frac{dT}{dx} \quad a) q = \frac{\dot{Q}}{A} = \frac{60}{0.74 \cdot 0.5} = 162 \frac{W}{m^2}$$

$$b) \dot{e}_{\text{gen}} = \frac{\dot{Q}}{V} = \frac{60}{0.74 \cdot 0.5 \cdot 0.05} = 8108.11 \frac{W}{m^3}$$

$$c) \frac{1}{r^n} \cdot \frac{d}{dr} \left( r^n \cdot \frac{dT}{dr} \right) + \frac{\dot{e}_{\text{gen}}}{k} = 0 \quad n=0 \rightarrow \frac{d}{dr} \left( \frac{dT}{dr} \right) + \frac{\dot{e}_{\text{gen}}}{k} = 0 \rightarrow$$

$$\frac{d^2T}{dr^2} + \frac{\dot{e}_{\text{gen}}}{k} = 0 \rightarrow \frac{d^2T}{dr^2} = -\frac{\dot{e}_{\text{gen}}}{k} \rightarrow \int \frac{d^2T}{dr^2} = \int -\frac{\dot{e}_{\text{gen}}}{k} \rightarrow$$

$$\frac{dT}{dr} = -\frac{\dot{e}_{\text{gen}}}{k} \cdot r + C_1 \rightarrow \int \rightarrow T(r) = -\frac{\dot{e}_{\text{gen}}}{2k} r^2 + C_1 r + C_2$$

$$d) \frac{dT}{dx} = C_3 \rightarrow \int \rightarrow T_2(x) = C_3 x + C_4$$

e)  $T_{\text{kontakman?}}$  ( $C_1, C_2, C_3, C_4$  atara)

$$\bullet T_2(x) = C_3 x + C_4 \rightarrow T(0.05) = 35 = C_3 \cdot 0.05 + C_4 \quad (T \text{ etaj}) \rightarrow C_4 = 65.26$$

$$\bullet 0 = -k \cdot A \cdot \left( -\frac{\dot{e}_{\text{gen}}}{k} \cdot 0 + C_1 \right) \rightarrow 0 = -k A C_1 \rightarrow C_1 = 0 \quad (Q \text{ etaj})$$

$$\bullet q_1 = q_2 \rightarrow -80.2 \cdot \left( -\frac{8108.11}{80.2} \cdot 0 + 0 \right) = -0.268 \cdot C_3 \rightarrow C_3 = 605.1 \quad (Q_{\text{ak berdinu})}$$

$$\bullet T_{0.02} \rightarrow C_3 \cdot 0.02 + C_4 = -\frac{\dot{e}_{\text{gen}}}{k_1} \cdot 0.02^2 + C_1 \cdot 0.02 + C_2 \rightarrow -605.1 \cdot 0.02 + 65.26 = -\frac{8108.11}{80.2} \cdot 0.02^2 + C_2 \rightarrow C_2 = 53.2$$

$$T(0.02) = -605.1 \cdot 0.02 + 65.26 = 53.16^\circ C$$

f) Sandwichak  $\leftarrow$   $\frac{Q_{\text{erap}}}{A} = \frac{\dot{Q}}{A} = \frac{60}{0.74 \cdot 0.5} = 162 \frac{W}{m^2}$   $\leftarrow$   $Q_{\text{erap}} = \dot{e}_{\text{gen}} \cdot V = 8108.11 \cdot 0.74 \cdot 0.5 \cdot 0.05 = 161.7 \frac{W}{m^2}$

$$g) h? \quad k_{\text{eff}} = h \cdot (T_s - T_{\text{air}}) + 16.17 \rightarrow h = \frac{162 - 16.17}{35 - 27} = 18.25 \frac{W}{m^2 \cdot ^\circ C}$$

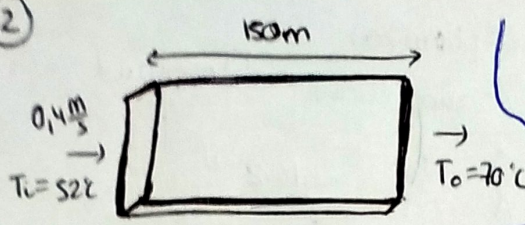
$$h) L_c = \frac{A}{P} \text{ izauiz, } Nu? \quad L_c = \frac{0.74 \cdot 0.5}{0.74 \cdot 2 + 0.5 \cdot 2} = 0.149 m$$

$$Nu = \frac{L_c \cdot h}{k} = \frac{0.149 \cdot 18.25}{0.268} = 10.16 \approx 103$$

$$k(35^\circ C) = 0.02625$$



2)



a)  $L_h$ ?  $L_t$ ?  $L_c = D_h = \frac{4 \cdot A_c}{P} = \frac{4 \cdot 0,045}{2 \cdot 0,3 + 2 \cdot 0,15} = 0,2$   
 $Re = \frac{V \cdot L_c}{\nu} = \frac{0,4 \cdot 0,2}{1,896 \cdot 10^{-3}} = 4219,4 < 5000 \rightarrow \text{Laminar}$   
 $T_f = \frac{52+70}{2} = 61^\circ\text{C}$   
 $Pr(60^\circ\text{C}) = 0,7202$   
 $L_h = 0,05 \cdot Re \cdot D_h = 42,19 \text{ m}$   
 $L_t = Pr \cdot L_h = 30,39 \text{ m}$

$A_b = 2 \cdot 150 \cdot 0,3 + 2 \cdot 150 \cdot 0,15 = 135 \text{ m}^2$

$A_c = 30 \cdot 15 \text{ cm}^2 = 0,045 \text{ m}^2$

b)  $h$ ?  $h$  lorteko  $\rightarrow Nu$   
 $150 \cdot 0,3 = 45 > L_h, L_t \rightarrow \text{Guztiz garatua}$

$\frac{a}{b} = \frac{0,3}{0,15} = 2 \xrightarrow{As=ke} Nu = 4,12 = \frac{h \cdot D_h}{k} \rightarrow 0,578 \frac{\text{W}}{\text{m}^2 \cdot \text{K}}$   
 $k(60^\circ\text{C}) = 0,02808$

$As=ke$

c)  $\dot{m}$ ?  $m = V \cdot \rho \cdot A_c = 0,4 \cdot 1,059 \cdot 0,045 = 0,02 \frac{\text{kg}}{\text{s}}$   
 $\rho(60^\circ\text{C}) = 1,059$

d) Pot irabaria?  $= \dot{Q}$

$\dot{Q} = \dot{m} C_p \cdot (T_o - T_i) = 0,02 \cdot 1007 \cdot (70 - 52) = 345,5 \text{ W}$

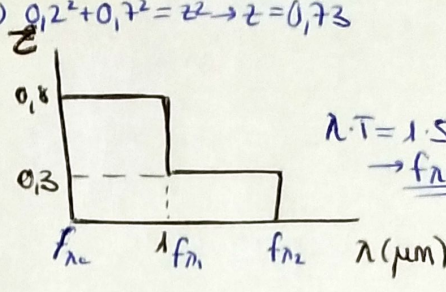
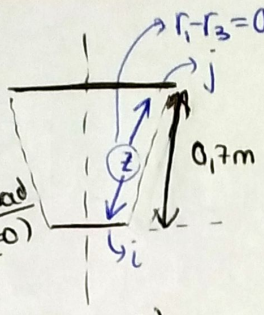
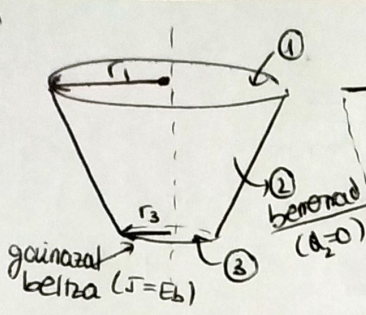
e)  $T_s = T_m + q/h$   
 $T_{s,i} = 52 + \frac{345,5/135}{0,578} = 56,43^\circ\text{C}$   
 $T_{s,o} = 70 + \frac{345,5/135}{0,578} = 74,43^\circ\text{C}$

$T_s = k_{re}$

e)  $h$ ?  $\dot{Q}$



3)



$T_{\text{gáz}} = 5800K$   
(sugárzó felület)

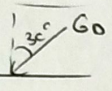
$\lambda \cdot T = 1.5800K = 5800K \rightarrow$

$\rightarrow f_{\lambda_1} = 0.720158$

$E_b = T^4 \cdot \sigma$

$E_b(T) = E_b(f_{\lambda_1} - f_{\lambda_2})$

$r_1 = 0.7m \rightarrow A_1 = 1.54m^2$   
 $\epsilon_2 = 0.1 \rightarrow A_2 = 2.75m^2$   
 $r_3 = 0.5m \rightarrow A_3 = 0.785m^2$



b)  $G_D = 1100 \frac{W}{m^2}$   
 $\alpha = 30^\circ$

$G_{\text{Solar}} = 1100 \cos 30^\circ + G_D \sin^2 30^\circ = 952.63 \frac{W}{m^2} \xrightarrow{0.66} 628.73 \frac{W}{m^2} \cdot 1.54m^2 = 968.25W$

$G_z = \dot{Q}_1 = 1050W$  ;  $T_3 = 150^\circ C$  ;  $T_2 = 40^\circ C$

3) F-ak

$F_{11} = 0$	$F_{12} = 0.78$	$F_{13} = 0.22$
$F_{21} = 0.44$	$F_{22} = 0.4$	$F_{23} = 0.16$
$F_{31} = 0.43$	$F_{32} = 0.57$	$F_{33} = 0$

$F_{12}$  analitikail:  $R_i = 0.71$   $R_j = 1$   $S = 4.97$

$F_{34} = \frac{1}{2} \left[ 4.97 + \left[ 4.97^2 - 4 \cdot \left( \frac{0.7}{0.5} \right)^2 \right]^{1/2} \right] = 0.43$

$F_{31} \cdot A_3 = F_{13} \cdot A_1 \rightarrow F_{13} = 0.22$

$F_{32} \cdot A_3 = F_{23} \cdot A_2 \rightarrow F_{23} = 0.16$

$F_{21} \cdot A_1 = F_{12} \cdot A_2 \rightarrow F_{21} = 0.44$

4)  $J_1, J_2, J_3 \rightarrow J_3 = E_{b3} = (150+273)^4 \cdot 5.67 \cdot 10^{-8} = 1815.28$

$J_1 = 2826$   $J_2 = 2238$

$0 = A_2 \cdot [F_{21}(J_2 - J_1) + F_{23}(J_2 - J_3)] \rightarrow F_{21}(J_1 - J_2) = F_{23}(J_2 - J_3)$   
 $0.1050 = A_1 \cdot [F_{12}(J_1 - J_2) + F_{13}(J_1 - J_3)] \rightarrow 681.82 = 0.78J_1 - 0.78J_2 + 0.22J_1 - 0.22J_3 \rightarrow$   
 $681.82 = J_1 - 0.78J_2 - 400 \rightarrow J_1 = 1081.2 + 0.78J_2$

$\rightarrow 0.44(1081.2 + 0.78J_2 - J_2) = 0.16(J_2 - 1815.28) \rightarrow 475.7 + 0.09J_2 = 0.16J_2 - 290.44 \rightarrow J_2 =$

5)  $\dot{Q}_3?$   $\dot{Q}_3 = A_3 \cdot [F_{31}(J_3 - J_1) + F_{32}(J_3 - J_2)] = 0.785 [0.43(1815.28 - 2826) + 0.57(1815.28 - 2238)]$   
 $\dot{Q}_3 = -535W$

6)

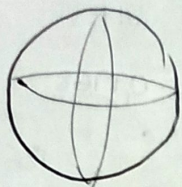


2015-06-23

Datavak:  $\rho_{air} = 8053$   $C_p = 480$   $k = 20$   $h = 25$   
(aluhaina)

$T_{air} = 30^\circ C$

1) Difuzibilitate termikea ( $\alpha$ )  $\alpha = \frac{k}{\rho \cdot C_p}$   $\alpha = \frac{20}{480 \cdot 8053} = 5,174 \cdot 10^{-6} \frac{m^2}{s}$



$\phi = 0,15 m$

$T_i = 350^\circ C$

↓ hokketa

$T_o = 35^\circ C$

$L_c = \frac{V}{A_s} = \frac{\frac{4}{3}\pi r^3}{4\pi r^2} = \frac{r}{3}$

$L_c = 0,025$

2) Hokketa denbora,  $t$  (seg)  $Bi = \frac{h \cdot L_c}{k} = \frac{25(0,025)}{20} = 0,03125 < 0,1$  konte

Analytikoki  $\rightarrow \left[ \frac{T - T_o}{T_i - T_o} = e^{-bt} \right]$   $b = \frac{h \cdot A_s}{\rho V C_p}$

$b = \frac{25 \cdot 4\pi r^2}{8053 \cdot \frac{4}{3}\pi r^3 \cdot 480} = \frac{1}{L_c} = 2,587 \cdot 10^{-4}$

$\frac{35-30}{350-30} = e^{-2,587 \cdot 10^{-4} t}$

$\rightarrow \ln(0,0156) = -2,587 \cdot 10^{-4} \cdot t \cdot \ln e \rightarrow t = 16076,1 s$

$\Delta W = \frac{J}{s}$

3) Q?  $E = m \cdot C_p \cdot (T_i - T_o) = \rho V \cdot C_p \cdot (T_i - T_o) = 8053 \cdot \frac{4}{3}\pi \left(\frac{0,15}{2}\right)^3 \cdot 480 \cdot (350 - 35) = 2,52 \cdot 10^6 J$

↳ Energia = J

4)  $T_{air} = 30^\circ C$  ; hokketa  
 $h_{max}?$



2) Hodi bikoteko bero trukateakilea

1)  $\dot{Q} = \dot{m} \cdot c_p \cdot \Delta T \Rightarrow \dot{Q}_{\text{aira}} = 0,1 \cdot (200 - 140) = 6105 \text{ W}$   
 $c_p \left( \frac{140 + 200}{2} = 170^\circ\text{C} \right) = \frac{1016 + 1019}{2} = 1017,5$

2)  $6105 = 0,04 \cdot 4180 (T_o - 25) \rightarrow T_{o,\text{ara}} = 61,5^\circ\text{C}$   
 $\dot{Q} = U A_s \Delta T_{\text{em}} \quad \Delta T_{\text{em}} = \frac{(200 - 61,5) - (140 - 25)}{\ln \left( \frac{200 - 61,5}{140 - 25} \right)} = 126,4^\circ\text{C}$

3)  $U?$   
 $U = \frac{6105}{2\pi \cdot 0,1 \cdot 6 \cdot 126,4} = 12,81 \frac{\text{W}}{\text{m}^2 \cdot \text{K}}$

Ur fluxua

4)  $Re?$   $\rightarrow Re = \frac{V \cdot L_c}{\nu} = \frac{0,00128 \cdot 0,2}{6,209 \cdot 10^{-7}} = 413,9 < 2300 \rightarrow \text{Laminarra}$

$m = V \cdot \rho \cdot A \Rightarrow V = \frac{0,04}{999,9 \cdot \pi (0,2)^2} = 0,00128 \frac{\text{m}}{\text{s}}$

5) Sarrera: Quesak  
 $L_h = 0,05 \cdot Re \cdot Pr = 0,05 \cdot 413,9 \cdot 0,2 = 4,14 \text{ m}$   $L_t = Pr \cdot L_h = 4,135 \cdot 4,14 = 17,11 \text{ m}$

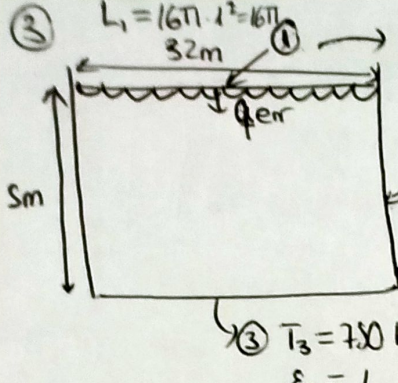
6)  $h?$   $Nu = 4,36 + \frac{0,625 \left( \frac{Pr}{L} \right) \cdot Re \cdot Pr}{1 + 0,04 \left[ \left( \frac{Pr}{L} \right) \cdot Re \cdot Pr \right]^{2/3}} = 4,36 + \frac{0,625 \cdot \left( \frac{0,2}{6} \right) \cdot 413,9 \cdot 4,135}{1 + 0,04 \cdot \left[ \left( \frac{0,2}{6} \right) \cdot 413,9 \cdot 4,135 \right]^{2/3}} = 6,69 \frac{h \cdot L_c}{K} \rightarrow$   
 $h = \frac{6,69 \cdot 0,6222}{0,2} = 20,8 \frac{\text{W}}{\text{m}^2 \cdot \text{C}} \quad 17,98 ??$

7)  $Re$  muxua;  $h_i$  eta  $U$  hartze,  $h_o?$   
 $\frac{1}{U} = \frac{1}{h_i} + \frac{1}{h_o} \rightarrow \frac{1}{12,81} = \frac{1}{20,8} + \frac{1}{h} \rightarrow h = 45 \frac{\text{W}}{\text{m}^2 \cdot \text{C}}$

8)  $D_h?$   $\rightarrow D_h = \frac{4 A_c}{P} = \frac{4 \cdot \pi (0,1)^2}{2\pi \cdot 0,11} = 0,02 \text{ m}$

9)  $Nu?$   $Nu = \frac{D_h \cdot h}{K} = \frac{0,02 \cdot 45}{0,03518} = 25,15$   
 $K = \frac{0,03518 + 0,03646}{2}$





$q_{gen,1} = 50.000 \frac{W}{m} \cdot 16$  a)  $\dot{Q}_{1,ref}$ ? b)  $F_{ak}$ ?  
 $\varepsilon_1 = 0,9$  a)  $Q_1 = 50 \frac{KW}{m} \cdot 16 = 800 \frac{KW}{m}$   
 b)  $F_{11} = ?$   $F_{12} = 0,072$   $F_{13} = ?$   
 $F_{21} = 0,46$   $F_{22} = 0,08$   $F_{23} = 0,46$   
 $F_{31} = 0,28$   $F_{32} = 0,072$   $F_{33} = 0$

$F_{13} \cdot L_1 = F_{31} \cdot L_3 \rightarrow$   
 $F_{13} = \frac{0,928 \cdot 32}{16\pi} =$

$F_{12}$  analitikkoki lortokke:  $F_{12} = \frac{1}{2} \left[ 1 + \frac{S}{32} - \left[ 1 + \left( \frac{S}{32} \right)^2 \right]^{1/2} \right] = 0,072 = F_{32}$   
 $F_{21} = \frac{1}{2} \left[ 1 + \frac{32}{S} - \left[ 1 + \left( \frac{32}{S} \right)^2 \right]^{1/2} \right] = 0,46 = F_{23}$

- c) Fak baxelakkak izanda,  $J_1, J_2, J_3$   
 d)  $T_1, T_2$   
 e)  $\dot{Q}_3$ ?

c)  $\begin{cases} 800 \cdot 10^3 = 16\pi [0,08 \cdot (J_1 - J_2) + 0,54 \cdot (J_1 - J_3)] \\ 0 = 8 \cdot [0,4(J_2 - J_1) + 0,49(J_2 - J_3)] \rightarrow 0,4(J_1 - J_2) = 0,49(J_2 - 17940) \rightarrow J_1 - J_2 = 0,225J_2 + 21976,5 \\ 5,56 \cdot 10^{-8} \cdot 750^4 = J_3 + 0 \rightarrow J_3 = 17940 \end{cases}$   
 $J_2 = 30226$   $J_1 = 45196$   
 $J_1 = 0,225J_2 + 21976,5$

\*  $\rightarrow 8 \cdot 10^3 = 16\pi [0,08 \cdot (0,225J_2 + 21976,5 - J_2) + 0,54 \cdot (0,225J_2 + 21976,5 - 17940)] \rightarrow$   
 $15915,5 = -0,258J_2 + 1758,12 = -1,2J_2 + 2179,71 \rightarrow J_2 =$

d)  $5,56 \cdot 10^{-8} \cdot T_1^4 = J_1 + \frac{1-0,9}{0,9} \cdot [F_{12} \cdot (J_1 - J_2) + F_{13} \cdot (J_1 - J_3)] \rightarrow T_1 = 954 K$

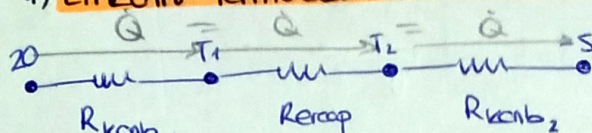
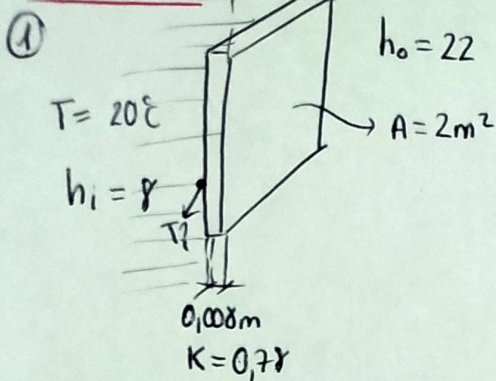
e)  $\dot{Q}_3 = \dot{Q}_{31} + \dot{Q}_{32} = \frac{J_3 - J_1}{R_{31}} + \frac{J_3 - J_2}{R_{32}}$   
 $R_{31} = \frac{1}{A}$

$\dot{Q}_3 = 32 \cdot [F_{31}^{0,85} \cdot (J_3 - J_1) + F_{32}^{0,15} \cdot (J_3 - J_2)] = -800,336 \frac{KW}{m}$



2014-05-20

T<sub>air</sub> = -5°C 1) Zirkuitu termoelektriko balizkidia



2)  $\dot{Q}$ ?  $\rightarrow \dot{Q} = \frac{\Delta T}{R_{\text{TOT}}}$   $R_{\text{konb}} = \frac{1}{As \cdot h}$   $R_{\text{erap}} = \frac{L}{k \cdot A}$

$R_{\text{konb}_1} = \frac{1}{2 \cdot 8} = \frac{1}{16} = 0,0625$   $R_{\text{konb}_2} = \frac{1}{2 \cdot 22} = 0,0227$

$R_{\text{erap}} = \frac{0,008}{0,78 \cdot 2} = 0,00513$   $\dot{Q} = \frac{20 - (-5)}{0,0625 + 0,0227 + 0,00513} = 276,68 \text{ W}$

3)  $T_1$ ?

$\dot{Q}_{\text{konb}} = 276,68 = 8 \cdot 2 \cdot (T_s - 20) \rightarrow T_s = 2,7^\circ\text{C}$

4) fluxu bolumetrikoa  $\rightarrow \dot{e}_{\text{gen}} = 25000 \frac{\text{W}}{\text{m}^3} \left( \frac{Q}{V} \right)$

Ekuazio dif. ordu  $\rightarrow \frac{1}{r^n} \frac{d}{dr} \left( r^n \cdot \frac{dT}{dr} \right) + \frac{\dot{e}_{\text{gen}}}{k} = 0 \xrightarrow{n=0} \frac{d}{dr} \left( \frac{dT}{dr} \right) + \frac{25000}{0,78} = 0 \rightarrow \frac{d^2 T}{dr^2} = -\frac{25000}{0,78} \rightarrow$

$\int \rightarrow \frac{dT}{dr} = -3205,13 r + C_1 \rightarrow \int \rightarrow T(r) = -1602,56 r^2 + C_1 r + C_2$

5) Ekuazioa ebatzi ( $C_1, C_2$ )  $\dot{Q}_{\text{erap}} = -k \cdot A \cdot \frac{dT}{dx}$

•  $r=0 \rightarrow T=T_1=C_2$

• formula  $\rightarrow h_i(20 - T_1) = -0,78 \cdot 2 \cdot (-3205,13 \cdot 0 + C_1) \rightarrow 8(20 - T_1) = -1,56 \cdot C_1$