Energia geotermikoa

1. Eguzkia

ϕ (lekua)

δ (eguna) → $\bar{E}_t$ → Denboraren ekuazioa (Spencer formula)

ω (ordua)

Ariketa) Kalkulatu Albaizeteko HSE

$$HSE = HSL - 4 \cdot (L_s - L_e) - E_t$$

$$4 \cdot (L_s - L_e) = 4 \cdot (0 - 1°52' \cdot \frac{1°}{60'}) = 4 \cdot (0 - 1'867°) = -7'469 \text{ min}$$

$$HSE = 12:00:00 + 7'28'' + 2'54'' \rightarrow HSE = 12:10:22$$

Eguzki-biltzaileak II

Adibidea)

$\phi = 39° + \frac{42}{60}$

$\beta = 35°$

$\Psi = 0°$

$J = 31+28+31+13$ ↘ δ Gen

3. Adibidea

$\dot{Q}_{egurtu} = G_T \cdot A_c \cdot \alpha \cdot \tau$

$\dot{Q}_L = U_L A_c F (T_j - T_\infty)$

$\dot{Q}_u = m \cdot C_p \cdot (T_o - T_i)$

$\eta = \frac{\dot{Q}_u}{G_T \cdot A_c}$

$A_c = 3\ m^2$

$G_T = 700\ W/m^2$

$\tau\alpha = 0'9$

$C_p = 4'18\ kJ/kg\,K$

$T = 30^\circ C$

$\varepsilon = 0'94$

$T_{sky} = -10^\circ C$

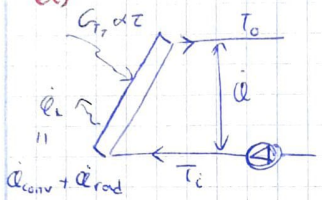
$q_{rad} = \varepsilon\sigma (T_s^4 - T_{sky}^4)$

$\dot{q}_{conv} = h (T_s - T_\infty)$

$h = 10\ W/m^2 K$

$T_\infty = 25^\circ C$

a)



$\dot{Q}_{egurtu} = G_T \cdot A_c \tau \cdot \alpha = 0'9 \cdot 3 \cdot 700 = 1890\ W$

$\dot{Q}_L = \dot{Q}_{conv} + \dot{Q}_{rad}$

$\dot{Q}_{conv} = h \cdot A_c (T_s - T_\infty) = 10 \cdot 3 \cdot (30-25) = 150\ W$

$\dot{Q}_{rad} = \varepsilon \cdot \sigma \cdot A_c (T_s^4 - T_a^4) = 0'94 \cdot 5'67 \cdot 10^{-8} (303^4 - 263^4) = 583'6\ W$

$\dot{Q}_u = 1890 - 150 - 583'6 \longrightarrow \dot{Q}_u = 1156'34\ W$

$\dot{q}_u = \frac{\dot{Q}_u}{A_c} = 385'5\ \frac{W}{m^2}$

b)

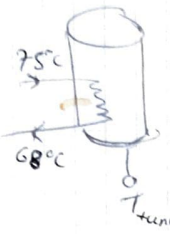
$\dot{Q}_u = 1156'34 = \dot{m} \cdot C_p \cdot \Delta T \longrightarrow \Delta T = \frac{\dot{Q}_u}{\dot{m} \cdot C_p} = \frac{1156'34}{0'01 \cdot 4180} \rightarrow \Delta T = 27'67^\circ C$

c)

$\eta = \frac{\dot{Q}_u}{A_c \cdot G_T} = \frac{1156'34}{3 \cdot 700} \longrightarrow \eta = \%\,55'1$

Bilteginak I

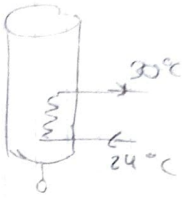
1. Adibidea)



$V = 3000\ \ell$

$T_m = 20°C$

$T_{tanka} = 61°C$



Karga

$\Delta t = 40 \cdot 60 = 2400\ s$

$\dot{m}_{prim} = 5\ \ell/s$

Bilketa

$\Delta t = 12 \cdot 3600$

Deskarga

$\Delta t = 45 \cdot 60 = 2700\ s$

$\dot{m}_{prim} = 5\ \ell/s$

Q_{t2} ?

T_{t3} ?

η_1, η_2, η_3?

$\dot{Q}_{karga} = \dot{m} \cdot C_p \cdot (T_{in} - T_{out}) \cdot \Delta t_1 = 5 \cdot 4'18 \cdot (75-68) \cdot 2400 \rightarrow Q_{karga} = 351120\ kJ$

$\dot{Q}_{karga} = \dot{Q}_{deskarga} + \dot{Q}_{galerak}$

$\dot{Q}_{deskarga} = \dot{m} \cdot C_p \cdot (T_{out}^{sek} - T_{in}^{sek}) \cdot \Delta t_3 = 5 \cdot 4'18 \cdot (30-24) \cdot 2700 \rightarrow Q_{deskarga} = 339480\ kJ$

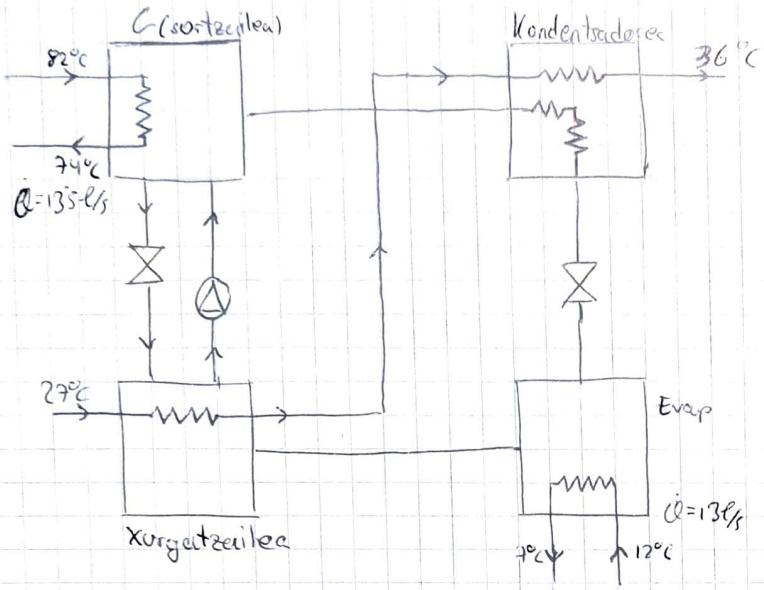
$\dot{Q}_{galerak} = \dot{Q}_{karga} - \dot{Q}_{deskarga} = 12540\ kJ$

$\dot{Q}_{galerak} = \dot{m} \cdot C_p \cdot (T_{t1} - T_{t2}) \rightarrow T_{t2} = 61 - \frac{12540}{3000 \cdot 4'18} \rightarrow T_{t2} = 60°C$

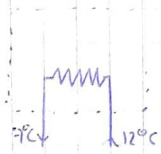
$\eta_1 = \%100 \qquad \eta_2 = 1 - \frac{12540}{351120} = \%96'4 \qquad \eta_3 = \%100 \rightarrow \eta_{tot} = \%96'4$

Eguzki hozketa

Adibidea



$\Delta E = Q - W = 0$



$\dot{Q}_{evap} = \dot{m}_{evap} \cdot C_p \cdot \Delta T$

$\dot{Q}_{evap} = 13 \cdot C_p \cdot (12-7)$

$\dot{Q}_{evap} = 271'7$ kW

$\dot{Q}_a = \dot{m}_a \cdot C_p \cdot \Delta T$

$\dot{Q}_a = 13'5 \cdot C_p \cdot (82-74) = 451'4$ kW

$\dot{Q}_{ref} = \dot{m}_{ref} \cdot C_p \cdot (36-7)$

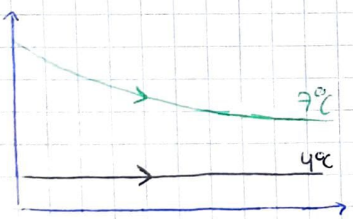
$\dot{Q}_a + \dot{Q}_{evap} + \cancel{W} = \dot{Q}_{ref} \rightarrow 451'4 + 271'7 = \dot{m}_{ref} \cdot 4'18 \cdot (9) \rightarrow \dot{m}_{ref} = 19'2$ l/s

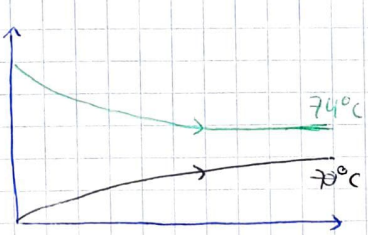
$EER = \frac{\dot{Q}_{evap}}{\dot{Q}_a} = \frac{271'7}{451'4} \rightarrow EER = 0'6$

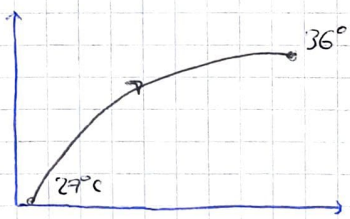
$EER^{max} = \left(1 - \frac{T_m}{T_c}\right) \cdot \left(\frac{T_{evap}}{T_{evap} - T_{cond}}\right) \rightarrow EER^{max} = 0'63$

(T_m = 70°C, T_c = 74°C)

→ Makina ona den etekin maximotik oso hurbil dagoelako







Eguzki energia termikoa

Eguzkia III

1) Palma de Mallorca: 39°34' I 2°39' E

Edimburgo: 55°57' I 3°10' M

Ekainak 4 eta Abenduak 4 → 4/06 → $\delta = +23'27°$ /// 4/12 → $\delta = -23'27°$

a) Eguzki izteera ordu ofiziala

Palma de Mallorca (4/06)

$$\cos\omega = \frac{-\sin(23'27)\cdot\sin(39'34)}{\cos(23'27)\cdot\cos(39'34)} = -\tan(23'27°)\cdot\tan(39'34°)$$

$\omega = -1.10'64°$

Egonsenti ordua $= 12 - \frac{1.1064°}{15°/h} = 4'62 = 4$ ordu 37 min 26 s → HSE-ren pasa !!

" " ofiziala = 6: 37. 26

Palma de Mallorca (4/12)

$\omega = \arccos(-\tan(-23'27°)\cdot\cos(39'34) = -69'36°$

Egunsenti ordu ofiziala $= 12 - \frac{69'36}{15°} + 1 = 8:22:33$

Edimburgo (4/06)

$\omega = \arccos(-\tan(23'27°)\cdot\tan(55'57°) \rightarrow \omega = 128'86°$

Egunsenti ordu ofiziala $= 12 - \frac{128'86°}{15} + 1 = 4:24:34$

Edimburgo (4/12)

$\omega = \arccos(-\tan(-23'27°)\cdot\tan(55'57°) \rightarrow \omega = -51'14$

Egunsenti ordu ofiziala $= 12 - \frac{51'14}{15} = 8:35:25$

b) Egunaren iraupena

Palma de Mallorca { 4/06 → $2\cdot 110'64\cdot 1/15 = 14'75$ h ; 4/12 → $2\cdot 69'36\cdot 1/15 = 9'25$ h

Edimburgo { 4/06 → $2\cdot 128'86\cdot 1/15 = 17'18$ h ; 4/12 → $2\cdot 51'14\cdot 1/15 = 6'82$ h

c) ~~Ordu ofiziala 12h~~ α eta Ψ? ordu ofiziala = 12h

Palma de Mallorca:

4/06 → OF: 12h → HSE: 10h → HSL = 10 + 4/(0-(-2'65)) + 2'1 = 9:51'30 10 baino gehiago

4/12 → OF: 12h → HSE: 11h → HSL = 11 + 4/(0-(-2'65)) + 4'54 = 10'98 h 11 baino gehiago

4/06 { $\omega = 32'125° \rightarrow \alpha = \arcsin(\sin(22'34)\cdot\sin(39'34) + \cos(22'34)\cdot\cos(39'34)\cdot\cos(32'125))$; $\alpha = 57'86 \rightarrow \cos\Psi = \frac{\sin(57'86)\cdot\sin(39'34) - \sin(22'34)}{\cos(57'86)\cdot\cos(39'34)} \rightarrow \Psi = 67'62°$

4/12 { $\omega = 15'25 \rightarrow \alpha = \arcsin(\sin(-22'14)\cdot\sin(39'34) + \cos(-22'14)\cdot\cos(39'34)\cdot\cos(15'25))$; $\alpha = 26'89 \rightarrow \cos\Psi = \frac{\sin(26'89)\cdot\sin(39'34) - \sin(-22'14)}{\cos(26'89)\cdot\cos(39'34)} \rightarrow \Psi = 15'84°$

2) Apirilaren 18 → $\delta = 9'84°$, $E_t = 0'02$

$\psi = 70° \rightarrow \alpha = 0°$

$HSL = 12h \rightarrow HSt = 11:44 \rightarrow Of = 9:44$

$\cos(\psi) = \frac{\sin(\delta)\cdot\sin\phi - \sin(9'84)}{\cos(\delta)\cdot\cos\phi} \rightarrow \phi = 60'02$

$HSE = HSL - 4(L_s - L_e) - E_t$

$11'73 = 12 - 4(-30 - L_e) - 0'02 \rightarrow L_e = -34° E$

Errusia

Kolektoreak II

1) $\phi = 39°42' = 39'7°$

$\beta = 35°$ $\psi = 0°$

Apirilaren 3a (10-11h)

$G = 520\ wh/m^2$

$\rho = 0'2$

$\delta = 8'01°$; $E_t = -3'75$

$I = G \cdot t$

$I = 520\ \frac{wh}{m^2} \cdot 1h \Rightarrow I = 520\ w/m^2$

$G_T = G_b \cdot R_b + G_d \cdot R_d + G \cdot \rho \cdot R_r$

$R_d = \frac{1+\cos\beta}{2} = \frac{1+\cos(35°)}{2} = 0'91$

$R_r = \frac{1-\cos\beta}{2} = \frac{1-\cos(\beta)}{2} = 0'09$

$R_b = \frac{\cos\theta}{\sin\delta\cdot\sin\phi + \cos\delta\cdot\cos\phi\cdot\cos\omega}$

$R_b = \frac{\cos(}{\sin(8'01)\cdot\sin(39'42) + \cos(8'01)\cdot\cos(39'42)\cdot\cos(-28'5)} =$

$k = \frac{G}{G_{on}} = \frac{520}{1371'64} \rightarrow k = 0'38$

$G_{on} = G_s\left(1+0'033\cdot\cos\left(\frac{360\cdot J}{365}\right)\right) = 1373\cdot(1+0'033\cdot\cos\left(\frac{360\cdot 98}{365}\right)) \rightarrow G_{on} = 1371'64$

$\frac{G_D}{G} = 0'951 - 0'1604k + 4'388k^2 - 16'678k^3 + 12'336k^4 \rightarrow \frac{G_D}{G} = 0'87$

2019-20 Geoaterketa (Gaztelera)

Ariketa)

Albacete: $\phi = 38^\circ 59'$

12:00 → $\omega = 0^\circ$

Martxoaren 3 → J/Et/d

$G_0 = 1'09$ kW/m²

$G_d = G \cdot 0'48$

$G = 1'09 + G\,0'48 \rightarrow G = \frac{1'09}{1-0'48} \rightarrow G = 2'09$ kW/m²

$G_T = G\,0'9$

$\rho G \cdot R_t = 0'02 \cdot G_T$

$R_t = \frac{0'02 \cdot 2'09 \cdot 0'9}{0'18 \cdot 2'09} \rightarrow R_t = 0'1$

$R_t = \frac{1-\cos\beta}{2} \rightarrow \beta = 36'87^\circ$

$G_d \cdot R_d = G \cdot 0'48 \cdot \frac{1+\cos\beta}{2} = 2'09 \cdot 0'48 \cdot \frac{1+\cos(36'87)}{2} \rightarrow G_d \cdot R_d = 0'903$ kW/m²

2019-20 (Euskara)

Ariketa)

$G_T = 1'09$ kW/m²

$\alpha \cdot \tau = 0'95$

$\rho = 0'18$

$\dot{Q}_L = G_T \cdot A_c \cdot \alpha \cdot \tau \cdot 0'1$

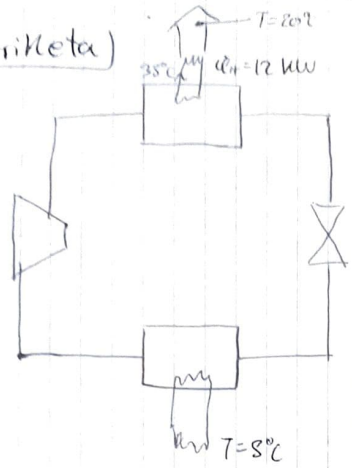
$\dot{Q}_u = 0'9 \cdot G_T \cdot A_c \cdot \alpha \cdot \tau = \dot{m} \cdot C_p \cdot \Delta T \rightarrow \Delta T = \frac{0'9 \cdot 1'09 \cdot 0'95}{0'1 \cdot 4'187} \rightarrow \Delta T =$

$\dot{m} = 1$ l/s

10 totu

Energia geotermikoa

Ariketa)



$COP = 3'2 = \frac{\dot{Q}_H}{\dot{W}} = \frac{\dot{Q}_H}{\dot{Q}_H - \dot{Q}_{ref}}$

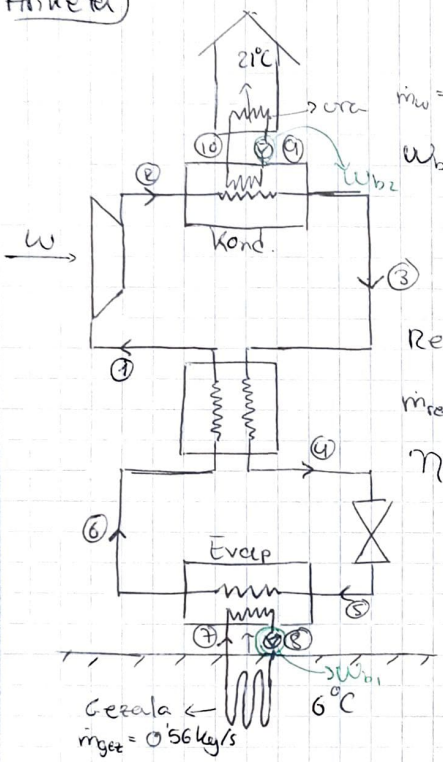
$T_{ba} = 0ºC$

a) $COP_{max} = \frac{T_H}{T_H - T_{fr}} = \frac{35+273}{35-5} = 10'7$

b) $\dot{W} = \frac{\dot{Q}_H}{3'2} = \frac{12}{3'2} = 3'75$ kw

c) $\dot{W} = \dot{Q}_H - \dot{Q}_c \rightarrow \dot{Q}_c = \dot{Q}_H - \dot{W} = 12 - 3'75 = 8'25$ kw

Ariketa)



$\dot{m}_w = 0'28$ kg/s

$\dot{W}_{b2} = 60$ W $\} \eta_{b2} = 0'52$

Refrig.

$\dot{m}_{ref} = 0'052$ kg/s $\} \dot{Q}_H = 9000$ W

$\eta_{comp} = 0'92$

$\dot{m}_{gez} = 0'56$ kg/s

$\dot{W}_{b1} = 60$ W $\} \eta_{wb1} = 0'52 = \frac{\dot{Q}_b}{\dot{W}_b}$

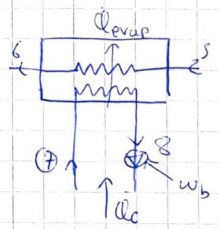
Galderak

a) $\dot{Q}_c$?

b) COP?

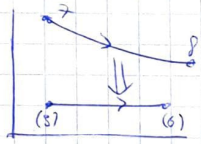
c) $\dot{Q}_{galeraik}$?

a)



$\dot{Q}_{evap} = \dot{m}_{ref}(h_6 - h_5) =$

$\dot{Q}_{evap} = \dot{m}_{gez}(h_7 - h_8) = 5660$ W

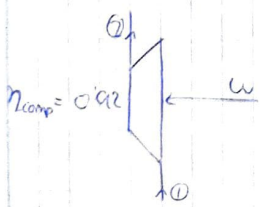


$\dot{Q}_c + \dot{Q}_b = \dot{Q}_{evap}$

$\dot{Q}_c = \dot{Q}_{evap} - \dot{Q}_b = 5660 - 60 \cdot 0'52 = 5630$ W

b)

$COP = \frac{9000 \text{ w}}{\dot{W}_{comp} + \dot{W}_{b1} + \dot{W}_{b2}} = \frac{9000}{3792 + 60 + 60} = 2'3$



$\eta_{comp} = \frac{\dot{m}_{ref} \cdot (h_2 - h_1)}{\dot{W}_{comp}}$

$\dot{W}_{comp} = \frac{\dot{m}_{ref}(h_2 - h_1)}{0'92} = 3792$ W

c) $\dot{Q}_{galeraik} = \dot{Q}_{gal}^{comp} + \dot{Q}_{gal}^{b1} + \dot{Q}_{gal}^{b2} + \dot{Q}_{gal}^{evap} + \dot{Q}_{gal}^{cond} + \dot{Q}_{gal}^{bero-berreskl} \rightarrow \dot{Q}_{galeraik} = 580'8$ W

$\dot{Q}_{gal}^{comp} = (1 - \eta_{comp})\dot{W}_{comp} = 303$ W

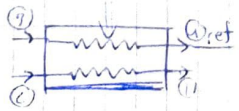
$\dot{Q}_{gal}^{b1} = (1 - \eta_{b1}) \cdot \dot{W}_{b1} = 29$ W

$\dot{Q}_{gal}^{b2} = (1 - \eta_{b2}) \cdot \dot{W}_{b2} = 29$ W

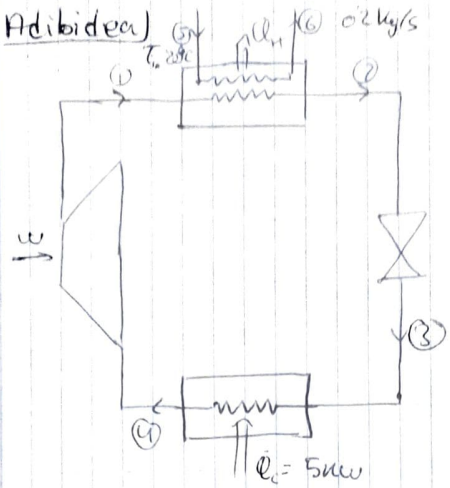
$\dot{Q}_{gal}^{evap} = \dot{m}_{gez}(h_7 - h_8) - \dot{m}_{ref}(h_6 - h_5) = -428$ W

$\dot{Q}_{gal}^{cond} = \dot{m}_{ref}(h_2 - h_3) - \dot{m}_w(h_0 - h_a) = 167$ W

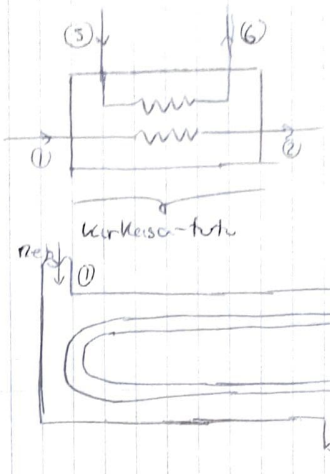
$\dot{Q}_{gal}^{bero-berreskl} = \dot{m}_{ref}(h_3 - h_4) - \dot{m}_{ref}(h_1 - h_6) = 10$ W

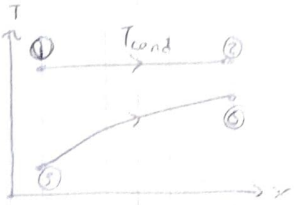


Adibidea)



$COP = 2'5 - 0'01 (T_{cond} - 30)$





$h_w = 1173\ W/m^2K$

$h_{ref} = 10000\ W/m^2K$

$N = 50$ fluk

$L = 3\ m$

$D_{in} = 0'02\ m \quad D_{out} = D_{in} + 2e$

$e = 0'001\ m$

$k = 15'1\ W/mK$

Kalderak

a) T_{cond} ?

b) $\dot{Q}_{cond}$?

c) $EER = 2'5 - 0'01 (T_{cond} - 30^\circ) = \frac{\dot{Q}_c}{\dot{Q}_H - \dot{Q}_c}$

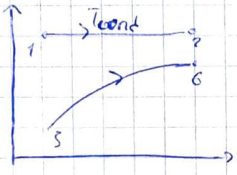
$$\dot{Q}_H = UA\Delta T_{ln} = UA \cdot \left(\frac{\Delta T_{in} - \Delta T_{out}}{ln\left(\frac{\Delta T_{in}}{\Delta T_{out}}\right)} \right)$$

$$\dot{Q}_{cond} = \dot{Q}_{ura}$$

$$\dot{Q}_{cond} = \dot{m}_g \cdot \Delta h_{fg} \quad [\text{ez dakigu } T_{cond} / P_{cond}]$$

2 ezezagun daude

$$\Delta T_{ln} = \frac{(T_{cond} - \overline{T_5}) - (T_{cond} - T_6)}{ln\left(\frac{T_{cond} - \overline{T_5}}{T_{cond} - T_6}\right)}$$



$$T_6 = T_{cond} - (T_{cond} - T_5) \cdot e^{\frac{-1}{R_{TOT}\,\dot{m}_w\,C_p}}$$

$$\dot{Q}_{ura} = \dot{m}_{ura} \cdot C_p \cdot (T_{cond} - (T_{cond} - \overline{T_5})\, e^{(\,)} - T_5)$$

$$\dot{Q}_{ura} = \dot{m}_{ura} \cdot C_p \cdot (T_{cond} - T_5) \cdot \left(1 - e^{\frac{-1}{\dot{m} \cdot C_p \cdot R_{TOT}}}\right)$$

$$A_{out} = \pi \cdot D_{out} \cdot L \cdot N = 10'367\ m^2$$

$$A_{in} = \pi \cdot D_{in} \cdot L \cdot N = 9'425\ m^2$$

$$R_{TOT} = \frac{1}{h_{ref} \cdot A_{out}} + \frac{ln\left(\frac{D_{out}}{D_{in}}\right)}{2\pi k L} + \frac{1}{h_{ura} \cdot A_{in}} = 9'646 \cdot 10^{-6} + 6'6972 \cdot 10^{-6} + 9'389 \cdot 10^{-4}$$