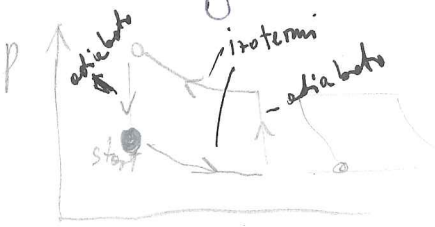
2

Naloga | HLADILNI STROJ | TOST | ~~2 TP~~ 25

Idealni hladilni stroj (toplotna črpalka) ponavlja Carnotovo krožno spremembo.

Stroj sprejme toplato (črpa) pri $T' = 280\ K$ in odda toplato pri višji temperaturi $T = 300\ K$. Kolika toplote prejme stroj, če mu dovedemo $20\ kJ$ dela?



$A_{kr} = 20\ kJ$

$T' = 280\ K$

$T = 300\ K$

$Q' = ?$

krožna sprememba:

$\Delta W_n = 0 = A_{kr} + Q' - |Q| \Rightarrow \boxed{-A_{kr} + |Q| = Q'}$

$\Delta S = 0 = \frac{Q'}{T'} - \frac{|Q|}{T} = 0 \Rightarrow \boxed{\frac{|Q|}{Q'} = \frac{T}{T'}}$ ali $\boxed{|Q| = Q' \frac{T}{T'}}$

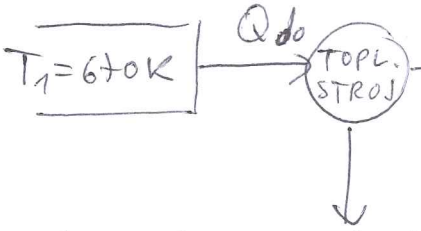
$\boxed{-A_{kr} + |Q| = Q'}$

$-A_{kr} + Q' \frac{T}{T'} = Q'$

$Q'\left(\frac{T}{T'} - 1\right) = A_{kr} \rightarrow \boxed{Q' = \frac{A_{kr}}{\left(\frac{T}{T'} - 1\right)}} =$

1

predelano S/44/2.1



2 ID 22

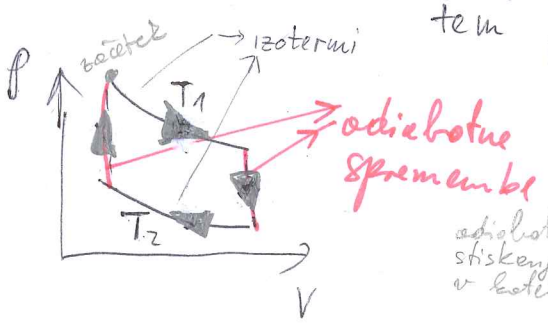
TOPLOTNI STROJ

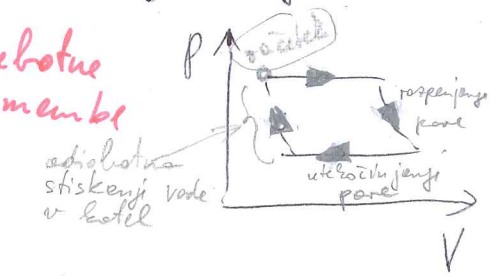
TOST

IDEALNI

Reverzibilni ~~f~~ toplotni stroj deluje med toplotnima rezervoarjema s temperaturama $T_1 = 670\,K$ ($397^\circ C$) in $T_2 = 270\,K$ ($-3^\circ C$).
Koliko dela odda ta stroj, če prejme od prvega rezervoarja toploto $|Q_{do}| = 100\,kJ$? Koliko je izkoristek tega stroja? Topl. stroj obravnavamo kot idealni.

TOPLOTNI STROJ ≡ prejema toploto, oddaja delo in pri tem ponavlja krožno spremembo





sistem, ki vsebuje dve fazi

krožna sprememba: $\Delta W_n = A_{kr} + Q_{kr} = 0 \Rightarrow -A_{kr} = Q_{kr}$

ali: $\Delta W_n = 0 = Q_{do} - |Q_{od}| + A_{kr} \Rightarrow -A_{kr} = Q_{do} - |Q_{od}|$

$\Delta S = 0 = \frac{Q_{do}}{T_1} - \frac{|Q_{od}|}{T_2} = 0 \Rightarrow \frac{|Q_{od}|}{Q_{do}} = \frac{T_2}{T_1}$

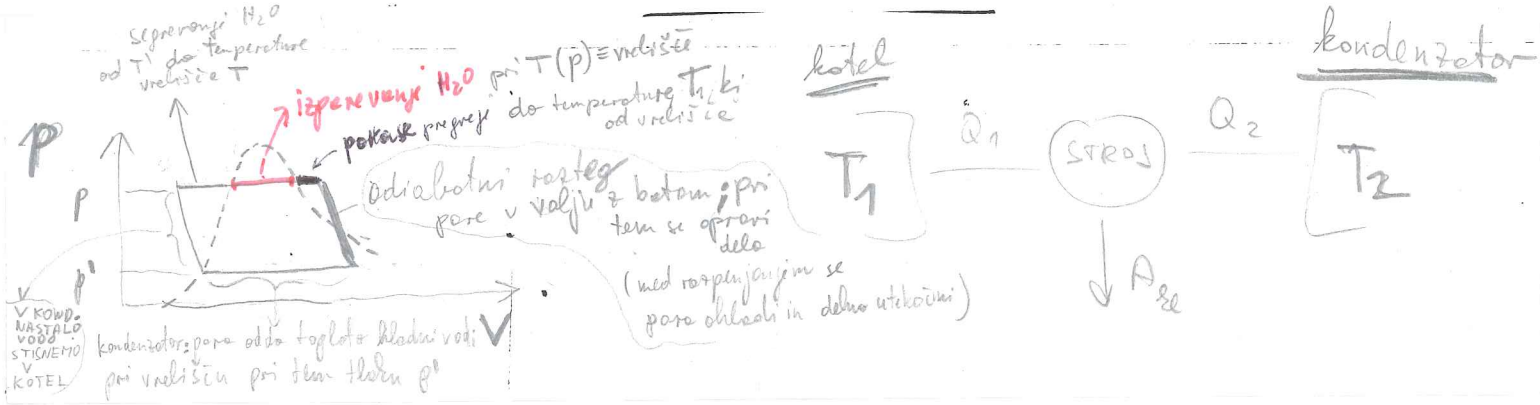
$\eta \equiv$ izkoristek, $\eta = \frac{|A_{kr}|}{Q_{do}} = \frac{Q_{do} - |Q_{od}|}{Q_{do}} = 1 - \frac{|Q_{od}|}{Q_{do}} = 1 - \frac{T_2}{T_1} = 0.597$

$$|A_{kr}| = Q_{do}\left(1 - \frac{T_2}{T_1}\right) = 59.7\,kJ$$

IDEALNI TOPLOTNI STROJ PONAVLJA
Carnotovo krožno spremembo (Strnad, str. 238)

1/2

5. Idealni parni stroj, ki ponavlja Carnotovo krožno spremembo, ima izkoristek 0,4. Temperatura kondenzatorja je 7°C. Izračunaj za koliko stopinj moramo povišati temperaturo v kotlu, da bi se izkoristek povečal za 0,1 ?



$\eta_z = 0.4$

$T_2 = 280\ K$

$\eta_k = 0.5$

$$\Delta W_n = A_{kr} + Q_1 - |Q_2| = 0 \Rightarrow \frac{-A_{kr}}{Q_1} = 1 - \frac{|Q_2|}{Q_1}$$

$$\Delta S = \frac{Q_1}{T_1} - \frac{|Q_2|}{T_2} = 0 \Rightarrow \frac{|Q_2|}{Q_1} = \frac{T_2}{T_1}$$

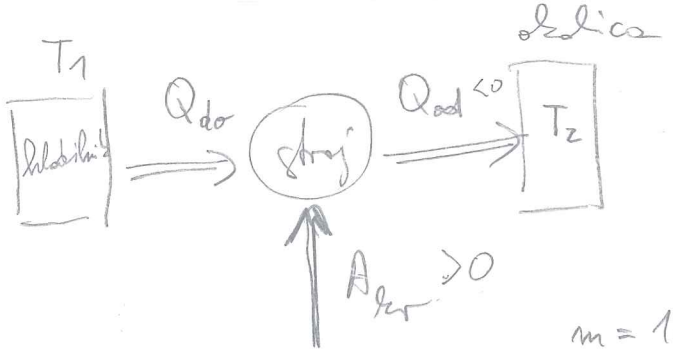
$$\eta = \frac{|A_{kr}|}{Q_1} = 1 - \frac{T_2}{T_1}$$

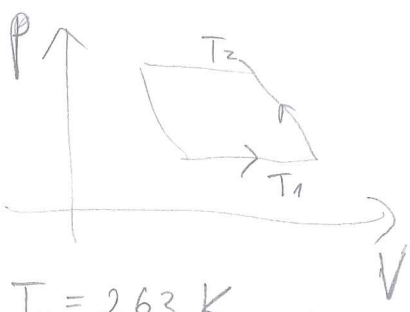
$$\eta_z = 0.4 = 1 - \frac{T_2}{T_1} \Rightarrow \frac{T_2}{T_1} = 1 - \eta_z \Rightarrow T_1 = \frac{T_2}{1-\eta_z} = 466{,}7\ K$$

$$\eta_k = 1 - \frac{T_2}{T_1 + \Delta T} \Rightarrow \Delta T = \frac{T_2}{1-\eta_k} - T_1 = 93{,}4\ K$$

kolokvij 1993/94

3. Iz vode s temperaturo $10^{\circ}C$ želimo dobiti led s temperaturo $0^{\circ}C$. Razmerje med prejetim delom in toploto, ki jo odda stroj hladilnika, je 0,1. Koliko energije porabi hladilnik za pridobitev 1 kg ledu ? (c_{p,H_2O} = 4200 J/(kg·K), q_{tal} = 334 kJ/kg)





$m = 1kg$, $T_V = 263\,K$, $T_0 = 273\,K$, $\alpha = 0.1$, $\frac{A_{kr}}{|Q_{od}|} = \alpha$

$A_{kr} = ?$

$$\Delta W_n = A_{kr} + Q_{do} - |Q_{od}| = 0$$

$$\Delta S = \frac{Q_{do}}{T_1} - \frac{|Q_{od}|}{T_2} = 0$$

$$Q_{do} = c_p m (T_0 - T_V) + m q_{tal}$$

$$\frac{A_{kr}}{|Q_{od}|} = \alpha$$

$$A_{kr} = |Q_{od}| - Q_{do} = \frac{A_{kr}}{\alpha} - Q_{do}$$

$$Q_{do} = A_{kr}\left(\frac{1}{\alpha} - 1\right)$$

$$\Downarrow$$

$$A_{kr} = \frac{Q_{do}}{\left(\frac{1}{\alpha} - 1\right)} = \frac{c_p m (T_0 - T_V) + m q_{tal}}{\left(\frac{1}{\alpha} - 1\right)} = 41{,}8 \cdot 10^3\ J$$

(?)

TOST

6. Oceni koliksna je razlika v delu, ki se dobi iz 1 kg črnega premoga ($q_{sež}$ = 30 MJ/kg) v idealnem parnem stroju, če ga uporabljamo pri poleti pri temperaturi 25° C ali jeseni pri temperaturi 7° C ? Temperatura v kotlu parnega stroja je 440° C.

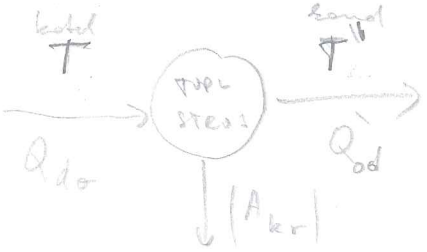
$T = 440°C = 713\ K$

$T_1 = 25°C = 298\ K$

$T_2 = 7°C = 280\ K$

$q = 30\ MJ/kg$

$m = 1\ kg$



$\Delta W_n = 0 = A_{kr} + Q_{do} - |Q'_{od}|$ (1)

$\Delta S = 0 \quad \frac{Q_{do}}{T} - \frac{|Q'_{od}|}{T'} = 0$ (2)

(1) $\Rightarrow \frac{A_{kr}}{Q_{do}} = \frac{|Q'_{od}| - Q_{do}}{Q_{do}} = \frac{|Q'_{od}|}{|Q_{do}|} - 1 = \frac{T'}{T} - 1$

(2) $\Rightarrow \frac{|Q'_{od}|}{|Q_{do}|} = \frac{T'}{T}$

$$A = -A_{kr} = Q_{do}\left(1 - \frac{T'}{T}\right)$$

$$Q_{do} = m \cdot q$$

$$\Delta A = A_2 - A_1 = Q_{do}\left[\frac{T - T_2}{T} - \frac{T - T_1}{T}\right] = mq \cdot \frac{T_1 - T_2}{T}$$

$= 7{,}57 \cdot 10^5\ J$

$\frac{1 \cdot 30 \cdot 10^6 \cdot (18)}{713} =$

0.582
0.607

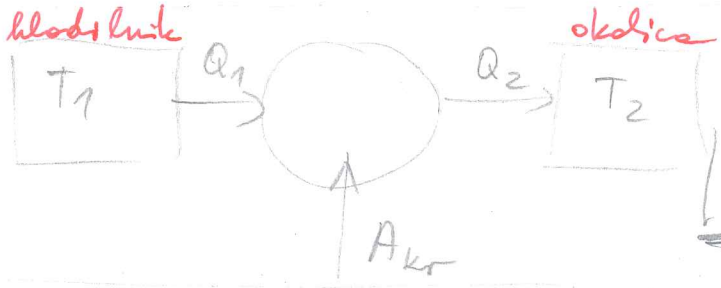
$\Delta A \approx 0.6$

0.58
0.6

(TOST) izpit 1991

2. Zaradi pomankljive izolacije priteče v hladilni prostor hladilnika s temperaturo - 25°C vsako minuto $4 \cdot 10^4$ J toplote. Hladilnik dela z močjo 110 W. Kolikšna je temperatura okolice, če je temperatura v hladilniku konstantna ?

1993



$P = 110\ W$

$T_1 = 248\ K$

$t_0 = 60\ s,\ Q_1 = 4 \cdot 10^4\ J$

$T_2 = ?$

$$\Delta S = \frac{Q_1}{T_1} - \frac{|Q_2|}{T_2} = 0 \Rightarrow |Q_2| = \frac{T_2}{T_1} Q_1$$

$$\Delta W_n = Q_1 - |Q_2| + A_{kr} = 0$$

$$Q_1 - \frac{T_2}{T_1} Q_1 + A_{kr} = 0 \Rightarrow \boxed{A_{kr} = Q_1 \left(\frac{T_2 - T_1}{T_1} \right)}$$

$$\boxed{P = \frac{A_{kr}}{t_0} = \frac{Q_1}{t_0} \left(\frac{T_2 - T_1}{T_1} \right)}$$

$$P = \frac{Q_1}{t_0} \left(\frac{T_2 - T_1}{T_1} \right) \Rightarrow P \cdot T_1 = \frac{Q_1}{t_0} (T_2 - T_1)$$

$$P \cdot T_1 = \frac{Q_1}{t_0} T_2 - \frac{Q_1}{t_0} T_1$$

$$\frac{Q_1}{t_0} T_2 = T_1 \left(P + \frac{Q_1}{t_0} \right)$$

$$T_2 = \frac{T_1 \cdot t_0}{Q_1} \left(P + \frac{Q_1}{t_0} \right) = T_1 + \frac{T_1 t_0 \cdot P}{Q_1} \Rightarrow$$

$$\boxed{T_2 = T_1 \left(1 + \frac{P t_0}{Q_1} \right)} = 288.9\ K = 15.9\ °C$$

5. V hladilniku, v katerem je temperatura 0°C, je pol kilograma vode pri temperaturi 0°C. Kolikšno delo opravi 100 W motor hladilnika, ko vsa vode zmrzne? Zunanja temperatura je 20°C, hladilnik pa deluje 10 krat slabše od idealnega hladilnega stroja. V hladilnih uhaja toplota skozi stene s površino 4 m². Stene obdaja 10 cm debela plast toplotnega izolatorja s toplotno prevodnostjo 0,05 W/mK.

1992 A-L

izolacija pušča

$T_h = 273\ K$

$T_z = 293\ K$

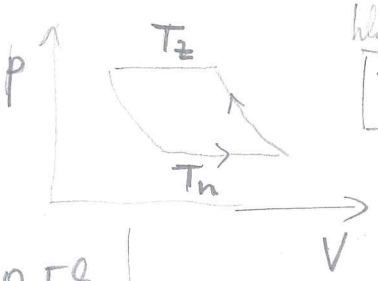
$P = 100\ W$

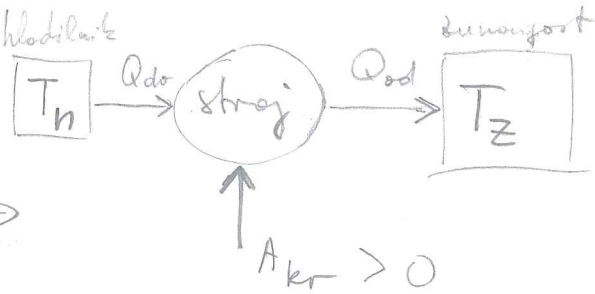
$\eta = 0{,}1 \cdot \eta_c$, $m = 0.5\,kg$

$l = 0{,}1\ m$, q

$\lambda = 50\ W/K$

$S = 4\ m^2$





$$\Delta S = 0 = \frac{Q_{do}}{T_h} - \frac{|Q_{odd}|}{T_z} = 0$$

$$\Delta W_h = 0 = A_{kr} + Q_{do} - |Q_{odd}| = 0$$

$$\frac{A_{kr}}{Q_{do}} = \frac{|Q_{odd}|}{Q_{do}} - 1 = \frac{T_z}{T_h} - 1$$

temp. v hladilniku konstantna (stac. stanje) ⇓

$$A_{kr} = Q_{do}\left(\frac{T_z}{T_h} - 1\right)$$ id. hl. stroj

$P_Q \rightarrow [\ T_h\ ] \leftarrow Q_{do}$

$$P \cdot t = A = 10 \cdot A_{kr}$$

$$Q_{do} = P_Q \cdot t + mq$$

$$P_Q = \lambda S \frac{(T_z - T_h)}{l}$$ topl. tok

$$P \cdot t = 10 \cdot A_{kr} = 10 \cdot Q_{do}\left(\frac{T_z}{T_h} - 1\right) = 10\left[\lambda S \frac{(T_z - T_h)}{l} \cdot t + m q_t\right]\left(\frac{T_z}{T_h} - 1\right)$$

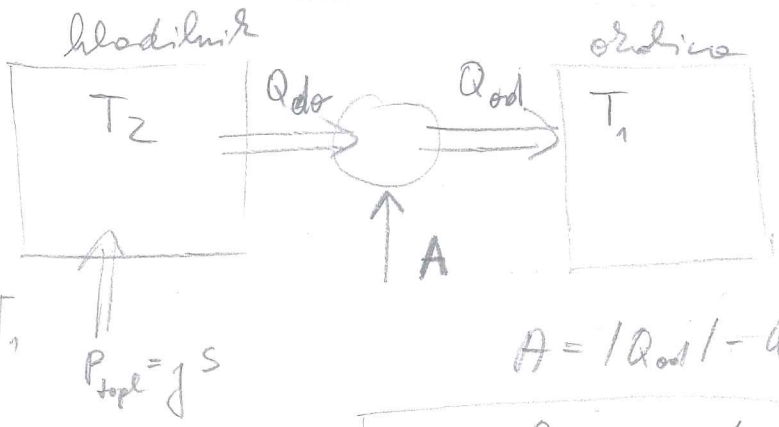
$$t = 10 \cdot m \cdot q_t \left(\frac{T_z}{T_h} - 1\right) \Big/ \left[P - 10\lambda \cdot S \frac{(T_z - T_h)}{l}\right] = 1800\ s$$ ✓

$$A = P \cdot t = 0{,}18\ MJ$$ ✓

(7)

7) Hladilnik s površino sten 6 m^2 je obložen s 4 cm debelo plastjo izolatorja, ki ima toplotno prevodnost 0.05 W/mK. Hladilnik ima motor z močjo 100 W. Kolikšno najnižjo temperaturo lahko dosežemo v hladilniku, če motor ves čas dela in je zunanja temperatura 25°C? Predpostavi, da gre za idealni Carnotov hladilnik!

$P_0 = 100\,W$
$S = 6\,m^2$
$d = 0{,}04\,m$
$\lambda = 0{,}05\,\frac{W}{mK}$
$T_1 = 25°C$



$$Q_{do} - |Q_{odd}| + A = 0$$

$$\frac{Q_{do}}{T_2} - \frac{|Q_{odd}|}{T_1} = 0$$

$$A = |Q_{odd}| - Q_{do} = Q_{do}\left(\frac{|Q_{odd}|}{Q_{do}} - 1\right) = Q_{do}\left(\frac{T_1}{T_2} - 1\right)$$

$$\eta = \frac{Q_{do}}{A} = \frac{1}{\frac{T_1}{T_2} - 1} = \frac{T_2}{T_1 - T_2}$$

$$\Downarrow$$

$$Q_{do} = A\,\frac{T_2}{T_1 - T_2}$$

$$\Downarrow$$

$$\frac{dQ_{do}}{dt} = \frac{dA}{dt}\,\frac{T_2}{T_1 - T_2}$$

$$\frac{dQ_{do}}{dt} = \frac{\lambda\,(T_1 - T_2)}{d}\,S$$

$$\frac{dA}{dt}\,\frac{T_2}{T_1 - T_2} = \frac{\lambda\,(T_1 - T_2)\,S}{d}$$

$\frac{dA}{dt} = P_0$

$$P_0 \cdot \frac{T_2}{T_1 - T_2} = \frac{\lambda S}{d} \cdot (T_1 - T_2)$$

$$\Downarrow$$

$$T_2^2 - T_2\left(2T_1 + \frac{P_0 d}{\lambda S}\right) + T_1^2 = 0$$

$$T_2 = \frac{2T_1 + \frac{P_0 d}{\lambda S} \pm \sqrt{\left(2T_1 + \frac{P_0 d}{\lambda S}\right)^2 - 4T_1^2}}{2} = 241{,}3\,K$$

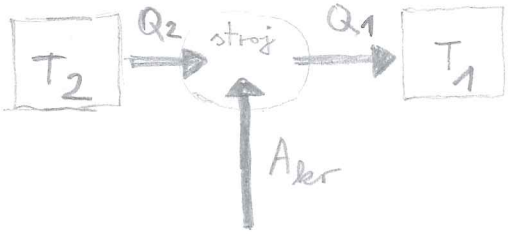
6. Za vzdrževanje temperature $-20^{\circ}C$ v notranjosti hladilnika je potrebna moč 100 W. Temperatura prostora v katerem se nahaja hladilnik je $17^{\circ}C$. Kolikšen toplotni tok prehaja iz okolice v hladilnik ? Za koliko procentov bi se zmanjšala potrošnja električne energije, če bi v notranjosti hladilnika vzdrževali temperaturo $-18^{\circ}C$?

14.8.

$T_2 = 253\ K$, $T_2' = 255\ K$

$T_1 = 290\ K$

$P = 100\ W$



$$0 = A_{ker} + Q_2 - |Q_1|$$

$$0 = \frac{Q_2}{T_2} - \frac{|Q_1|}{T_1}$$

$$A_{ker} = Q_2\left(\frac{T_1}{T_2} - 1\right)$$

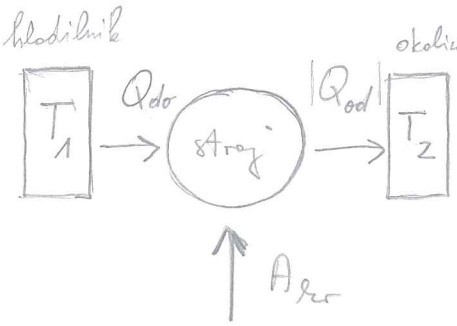
$$P = \frac{A_{ker}}{t}$$

$$\frac{Q_2}{t} = P\,\frac{T_2}{T_1 - T_2} = 684\ W$$

$$\Delta A_{ker} = -Q_2\,\frac{T_1}{T_2^2}\,\Delta T_2$$

$$\frac{\Delta A_{ker}}{A_{ker}} = -\frac{T_1}{T_1 - T_2}\cdot\frac{\Delta T_2}{T_2} = -0{,}06$$

4. Zaradi slabe izolacije priteče v hladilnik skozi stene vsako uro $1{,}8 \cdot 10^6$ J toplote. Koliko moči troši hladilnik, če želimo, da je v njem temperatura ves čas konstantna. Temperatura v hladilniku je -23°C, temperatura okolice pa je 27°C. 1892



$T_2 > T_1$

$Q_{do} = 1{,}8 \cdot 10^6$ J

$t_0 = 3600$ s

$T_1 = 250$ K

$T_2 = 300$ K

ΔW_n: $0 = A_{er} + Q_{do} - |Q_{od}|$

ΔS: $0 = \frac{Q_{do}}{T_1} - \frac{|Q_{od}|}{T_2}$

$$A_{ker} = |Q_{od}| - Q_{do} = Q_{do}\left(\frac{|Q_{od}|}{Q_{do}} - 1\right) =$$

$$= Q_{do}\left(\frac{T_2}{T_1} - 1\right)$$

$\frac{Q_{do}}{A_{ker}} = \frac{T_1}{T_2 - T_1}$

$$P = \frac{A_{ker}}{t_0} = \frac{Q_{do}}{t_0}\left(\frac{T_2}{T_1} - 1\right) = 100 \text{ W}$$ ✓

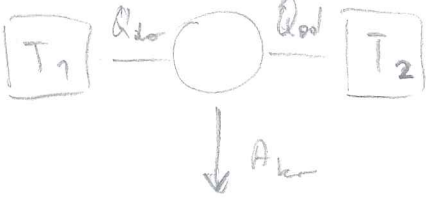
3

2. Reverzibilni idealni toplotni stroj deluje med toplotnima rezervoarjema s temperaturama 397°C in -3°C. Kolikšno delo lahko v idealnem primeru odda ta stroj, če prejme od prvega rezervoarja 100 kJ toplote?

$T_1 = 670\ K$

$T_2 = 270\ K$

$Q_{do} = 100\ kJ$



$$0 = A_{ker} + Q_{do} - |Q_{od}|$$

$$0 = \frac{Q_{do}}{T_1} - \frac{|Q_{od}|}{T_2}$$

$$\mu = \frac{-A_{ker}}{Q_{do}} = 1 - \frac{|Q_{od}|}{Q_{do}} = 1 - \frac{T_2}{T_1}$$

$$|A_{ker}| = \left(1 - \frac{T_2}{T_1}\right) Q_{do} =$$

$$= 59.7\ kJ$$

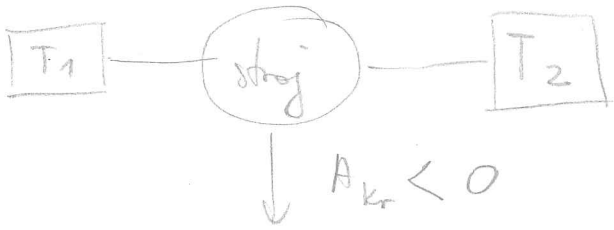
TOST kolokvij 30/31

4. Toplotni stroj dela z izkoristkom, ki je trikrat manjši od izkoristka idealnega toplotnega stroja. Temperatura kotla je 800 °C, temperatura kondenzatorja pa 200 °C. Kotel segrevamo tako, da sežigamo snov s $q_{sežigna} = 42 \cdot 10^6$ J/kg. Kolikšni masni tok goriva troši stroj, če dela z močjo 10 kW.

TOST

$T_1 = 1073$ K

$T_2 = 473$ K



$\eta_{ID} = 1 - \frac{T_2}{T_1}$

$\boxed{\eta = \eta_{ID}/3}$

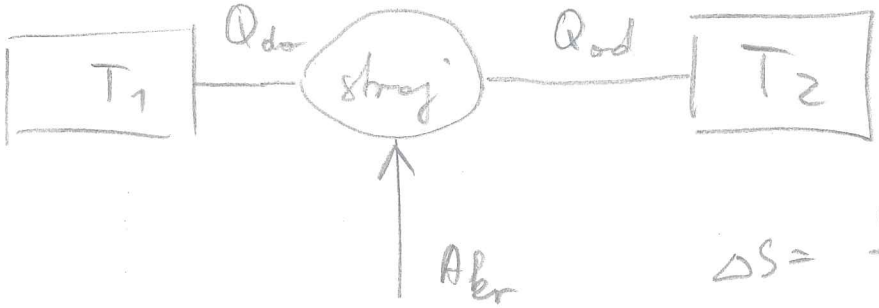
$|A_{kr}| = \eta \cdot Q_{dov}$, $Q_{dov} = m \cdot q_s$, $\eta = 18.6\,\%$

$$P = \frac{|A_{kr}|}{t} = \frac{\eta \cdot Q_{dov}}{t} = \frac{\eta\, m \cdot q_s}{t} = \eta \cdot \phi_m \cdot q_s$$

$$\phi_m = \frac{P}{\eta \cdot q_s} = 1{,}28 \cdot 10^{-3}\ \mathrm{kg\,s^{-1}}$$

kolokvij 30/31

4. V hladilniku je treba 100 kg vode s temperaturo 0 °C zamrzniti v led enake temperature. Koliko dela je potrebno, če predpostavimo, da dela hladilnik po obrnjenem Carnotovem ciklusu. Temperatura okolice 27 °C. (talilna toplota ledu je $3{,}36.10^5$ J/kg).



$$\Delta S = \frac{Q_{do}}{T_1} - \frac{|Q_{od}|}{T_2} = 0$$

$$\Delta W_n = A_{kr} + Q_{do} - |Q_{od}| = 0$$

$T_1 = 273\ K$

$T_2 = 300\ K$

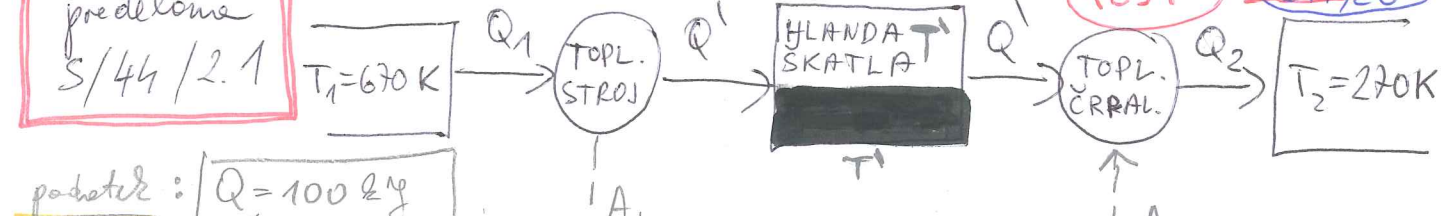
$q_{tal} = 3{,}36 \cdot 10^5\ J/kg$

$m = 100\ kg$

$$A_{kr} = Q_{do}\left(\frac{T_2}{T_1} - 1\right)$$

$$A_{kr} = m \cdot q_{tal}\left(\frac{T_2}{T_1} - 1\right) = 33{,}2 \cdot 10^5\ J$$

predelana S/44/2.1



podatki:
$Q = 100\,kJ$
$T_1 = 670\,K$
$T_2 = 270\,K$

topl. stroj, hladilnik } idealna krožna sprememba

$$A = |A_{ts}| - |A_{he}| = ?$$

---

topl. stroj:

$$\Delta W_n = 0 = A_{ts} + Q_1 - |Q'| \Rightarrow A_{ts} = -Q_1 + |Q'|$$

$$\Delta S = \frac{Q_1}{T_1} - \frac{|Q'|}{T'} = 0 \Rightarrow |Q'| = \frac{T'}{T_1} Q_1$$

$$A_{ts} = -Q_1 + |Q'| = -Q_1 + \frac{T'}{T_1} Q_1 = Q_1 \left(\frac{T'}{T_1} - 1\right)$$

$$-A_{ts} = Q_1 \left(1 - \frac{T'}{T_1}\right) = \frac{Q_1}{T_1}(T_1 - T')$$

hladilni stroj:

$$\Delta W_n = 0 = A_{he} + |Q'| - |Q_2| \Rightarrow A_{he} = |Q_2| - |Q'|$$

$$\Delta S = 0 = \frac{|Q'|}{T'} - \frac{|Q_2|}{T_2} = 0 \Rightarrow |Q_2| = \frac{T_2}{T'} |Q'|$$

$$A_{he} = |Q_2| - |Q'| = \frac{T_2}{T'} |Q'| - |Q'| = |Q'| \left(\frac{T_2}{T'} - 1\right)$$

SKUPNO:

$$A_{he} = \frac{T'}{T_1} Q_1 \left(\frac{T_2}{T'} - 1\right) = \frac{Q_1}{T_1}(T_2 - T')$$

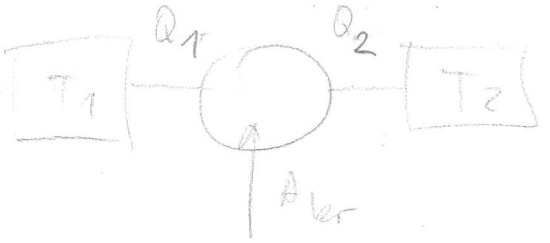
$$A = |A_{ts}| - |A_{he}| = \frac{|Q_1|}{T_1}(T_1 - T') - \frac{|Q_1|}{T_1}(T_2 - T') \Rightarrow$$

$$A = Q_1 \cdot \left(\frac{T_1 - T_2}{T_1}\right) = 59{,}7\,kJ$$

kolokvij 80/81 (TOST)

4. Iz vode s temperaturo 10°C želimo dobiti led s temperaturo 0°C. Izkoristek hladilnika je 10 %. Koliko energije prejme hladilnik za pridobitev 1 kg ledu ?

$\mathcal{L}_{tal} = 3.36 \cdot 10^5$ J/kg



$A_{ker} + Q_1 - |Q_2| = 0$

$\frac{Q_1}{T_1} - \frac{|Q_2|}{T_2} = 0 \Rightarrow |Q_2| = \frac{T_2}{T_1} Q_1$

$A_{ker} = |Q_2| - Q_1$

definicija:

$\gamma = \frac{Q_1}{A_{ker}}$

$\zeta = \frac{1}{\gamma}$

$A_{ker} = Q_1 \underbrace{\left(\frac{T_2}{T_1} - 1 \right)}_{\zeta} = Q_1 \cdot \gamma$

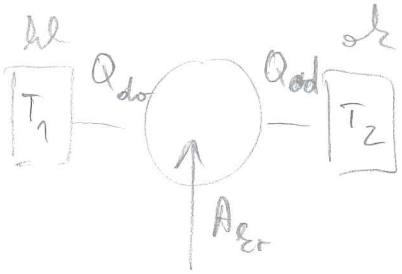
$Q_1 = mc_p \Delta T + m \mathcal{L}_{tal} = 3.78 \cdot 10^5$ J

$A_{ker} = \frac{1}{\gamma} Q_1 = 10 \cdot 3.78 \cdot 10^5$ J $= 3.78 \cdot 10^6$ J $= 3780$ kJ

(6)

6) Zamrzovalnik ima stene s skupno površino 10 m^2. Obdan je s 4 cm debelo plastjo izolatorja s toplotno prevodnostjo 0.2 W/mK. V zamrzovalniku je temperatura -20^o C, zunaj pa 20^o C. Najmanj s kolišno močjo mora delati motor v zamrzovalniku, da vzdržuje notranjo temperaturo, če je izkoristek dvakrat slabši, kot pri ustreznem Carnotovem hladilniku?

FOR 1993



$S = 10\ m^2$

$d = 4\ cm$

$\lambda = 0.2\ W/mK$

$T_1 = 253\ K$

$T_2 = 293\ K$

$$\frac{Q_{do}}{T_1} - \frac{|Q_{od}|}{T_2} = 0$$

$$Q_{do} - |Q_{od}| + A_{ker} = 0$$

$$\eta = \frac{Q_{do}}{A_{ker}} = \frac{Q_{do}}{|Q_{od}| - Q_{do}} = \frac{1}{\frac{|Q_{od}|}{Q_{do}} - 1} = \frac{1}{\frac{T_2}{T_1} - 1}$$

$$P_Q = \lambda \frac{S}{d}(T_2 - T_1)$$

$$Q_{do} = \eta A_{ker}$$

$$P_{hl} = \frac{Q_{do}}{t} = \eta \frac{A_{ker}}{t} = \eta P_x$$

$$P_Q = P_{hl}$$

$$\lambda \frac{S}{d}(T_2 - T_1) = \frac{1}{2} \frac{1}{\left(\frac{T_2}{T_1} - 1\right)} \cdot P_x$$

$$\Downarrow$$

$$P_x = \frac{2\lambda S}{d}(T_2 - T_1)\left(\frac{T_2}{T_1} - 1\right) = \underline{632\ W}$$

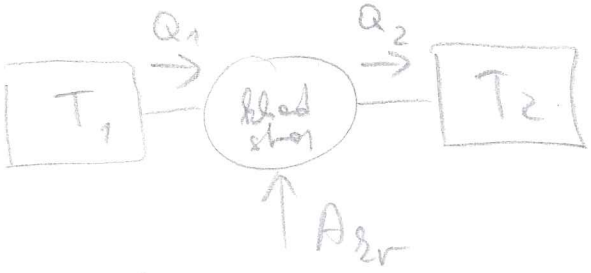
TOST Kolokvij 30/1/91

1. Kakšna je maksimalna količina toplote, ki jo lahko izčrpamo iz komore hladilnika, če porabimo 1kJ dela. Temperatura komore je -10°C, temperatura vode s katero se stroj hladilnika hladi pa je 11°C. N-7 Sa 78/18-19

$A = 1\,kJ$

$T_2 = 11°C = 284\,K$

$T_1 = -10°C = 263\,K$



$\Delta W_n = 0 = Q_1 - |Q_2| + A_{kr}$

$\Delta S = \frac{Q_1}{T_1} - \frac{|Q_2|}{T_2} = 0 \Rightarrow |Q_2| = \frac{T_2}{T_1} Q_1$

$0 = Q_1 - \frac{T_2}{T_1} Q_1 + A_{kr} = 0$

$A_{kr} = Q_1 \left(\frac{T_2}{T_1} - 1 \right) = Q_1 \frac{T_2 - T_1}{T_1}$

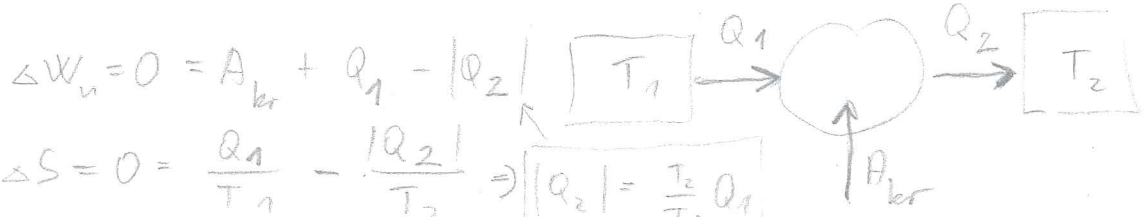
$$Q_1 = A_{kr} \frac{T_1}{T_2 - T_1} \Rightarrow \frac{Q_1}{A} = \frac{T_2 - T_1}{T_1} = \frac{T_2}{T_1} - 1$$

$Q_1 = 1\,kJ \frac{263}{21} = 12.52 \cdot 10^3\,J = 3\,kcal$

$\gamma = \frac{Q_{od}}{A} \qquad \zeta = \frac{A}{Q_{do}}$

4. Hladilni stroj pretvori v eni uri 200 kg vode z začetno temperaturo $0^{\circ}C$ v led s temperaturo $0^{\circ}C$. Kolikšna je moč motorja, če ima stroj polovico slabši učinek kot idealno delujoči hladilni stroj ? temperatura okolice je $20^{\circ}C$. ($q_{tal} = 3{,}36 \cdot 10^5$ J/kg)

1994



$$\Delta W_n = 0 = A_{kr} + Q_1 - |Q_2| \qquad \Delta S = 0 = \frac{Q_1}{T_1} - \frac{|Q_2|}{T_2} \Rightarrow \boxed{|Q_2| = \frac{T_2}{T_1} Q_1}$$

$$0 = A_{kr} + Q_1 - \frac{T_2}{T_1} Q_1 \Rightarrow A_{kr} = \left(\frac{T_2}{T_1} - 1\right) Q_1 = \frac{T_2 - T_1}{T_1} Q_1$$

$$\boxed{\gamma_{ID} = \frac{Q_1}{A_{kr}} = \frac{T_1}{T_2 - T_1}}$$

$$\boxed{Q_1 = m \cdot q_{tal}}$$

$$\boxed{A_{kr} = Q_1 / \gamma = \frac{2 \cdot Q_1}{\gamma_{ID}}}$$

$$P = \frac{A_{kr}}{t} = \frac{2\,Q_1}{\gamma_{ID} \cdot t} = \frac{2 \cdot m \cdot q_{tal} (T_2 - T_1)}{t \cdot T_1}$$

$$\boxed{P = \frac{2 \cdot m \cdot q_{tal} (T_2 - T_1)}{t \cdot T_1}} = 2.74 \cdot 10^3 \text{ W}$$

$m = 200$ kg
$T_1 = 273$ K
$\gamma = \gamma_{ID} / 2$
$T_2 = 253$ K
$t = 3600$ s