- ulaz $p_1 = 4\ MPa$ $T_1 = 700\ °C$

- izlaz $p_2 = 100\ kPa$

- ulaz $h_{1T} = 3445\ \frac{kJ}{kg}$ $s = 7091\ \frac{kJ}{kg}$

- izlaz $h' = 418\ \frac{kJ}{kg}$ $h'' = 2675\ \frac{kJ}{kg}$

$s' = 1303\ \frac{kJ}{kg}$ $s'' = 7360\ \frac{kJ}{kg\,K}$

$$s = s' + x(s'' - s')$$

$$7091 = 1303 + x(7360 - 1303)$$

$$6057 \cdot x = 5788 \Rightarrow x = 0.955588575$$

$$h_{1T} = 418 + 0.955588575\,(2675 - 418)$$

$$= 2574.76\ \frac{kJ}{kg}$$

② UNUTRAŠNJI STUPANJ DJELOVANJA TURBINE

$$\eta = \frac{3445 - 2675}{3445 - 2574.76} = \frac{770}{870.24} = 0.885$$

① TOPLINU ODVEDENU IZ KONDENZATORA

zbog sadržaja pare = 1 kako je zadano u zadatku

$h_4 = h'' = 2675\ \frac{kJ}{kg}$ $h_1 = h' = 418\ \frac{kJ}{kg}$

$$q_{odv} = h_4 - h_1 = 2,26\ \frac{MJ}{kg}$$

③ $Q = \frac{2}{3}(1300 - H)$

$Q_i = Q_{pr}(400m) = 600 \frac{m^3}{s}$ $\qquad H_{dv} = 385m$

$$H_{izvad} = \frac{Q}{10} = \frac{650}{10} = 65m$$

$$H_{gv} = 400 + 65m = 465m$$

$$H_{dspad} = \frac{Q}{200} = \frac{650}{200} = 3,25$$

$$H_{dv} = 385 + 3.25 = 388.25$$

$$H_n = 465 - 388,25 = 76.75$$

$$P = 9,81 \cdot 1000 \cdot 76.75 \cdot 600 = 452\ MW$$

④ $Q = 600 - 50t \quad \Rightarrow t = \frac{600 - Q}{50} = 12 - \frac{Q}{50}$

$H_n = 100\ m$

$\mu = 0{,}7$

$\mu = \frac{Q_{dr}}{Q_i}$

$\mu Q_i = Q_{dr}$

$$0{,}7 Q_i = \frac{1}{12}\left[\int_0^t Q_i \cdot dt + \int_t^{12} 600 - 50t\right]$$

$$0{,}7 Q_i \cdot 12 = Q_i \cdot t + 600(12 - t) - 25(12^2 - t^2)$$

$$t = \frac{600 - Q_i}{50}$$

$$8{,}4 Q_i = Q_i\left(12 - \frac{Q_i}{50}\right) + 600\left(12 - 12 + \frac{Q_i}{50}\right) - 25\left(12^2 - \left(12 - \frac{Q_i}{50}\right)^2\right)$$

$$8{,}4 Q_i = 12 Q_i - \frac{Q_i^2}{50} + 12 Q_i - 25\left(12^2 - 12^2 + 0{,}48 Q_i - 0{,}0004 Q_i^2\right)$$

$$8{,}4 Q_i = 24 Q_i - 0{,}02 Q_i^2 - 12 Q_i + 0{,}01 Q_i^2$$

$$0{,}01 Q_i^2 - 3{,}6 Q_i = 0$$

$$Q_i\left(0{,}01 Q_i - 3{,}6\right) = 0$$

$$\boxed{Q_i = 360\ \frac{m^3}{s}}$$

$Q_{dr} = 0{,}7 \cdot 360 = 252$

$W_j = 8760 \cdot 9{,}81 \cdot 100 \cdot 252$

$= 2166\ GWh$

(5) OE

$H = 25\ MJ/kg$

$P_m = 200\ MW$

$\eta = 0.4$

$m = 0.7$

$t = 1\ god \longrightarrow m(CO_2) = 1.4\ Mt$

Koliki je udio ugljika u ugljenu, ako pretpostavimo potpuno izgaranje?

$$W_{god.topl} = \frac{200\ MW}{0.4} \cdot 0.7 \cdot 8760 \cdot 3600\ s = 1.10376 \cdot 10^{10}\ MJ$$

$$m(ugljen) = \frac{W_{god.toplinska}\ [MJ]}{H\ \left[\frac{MJ}{kg}\right]} = 0.441504\ Mt$$

$C + O_2 \rightarrow CO_2$

$1\ mol\ C \rightarrow 1\ mol\ O_2$

$12\ g/mol\ C \rightarrow 32\ g/mol\ O_2$

$1\ kg\ C \longrightarrow \frac{32}{12}\ kg\ O_2$

$m(CO_2) = m(C) + m(O_2) = m(C)\left(1 + \frac{32}{12}\right)$

$m(C) = 0.381\ Mt$

• UDIO UGLJIKA U UGLJENU: $\frac{m(C)}{m(ugljen)} = 86.48\ \%$

EE

$P_{max} = 1100\ MW$, $P_k = 600\ MW \rightarrow T_k = 6\ h$

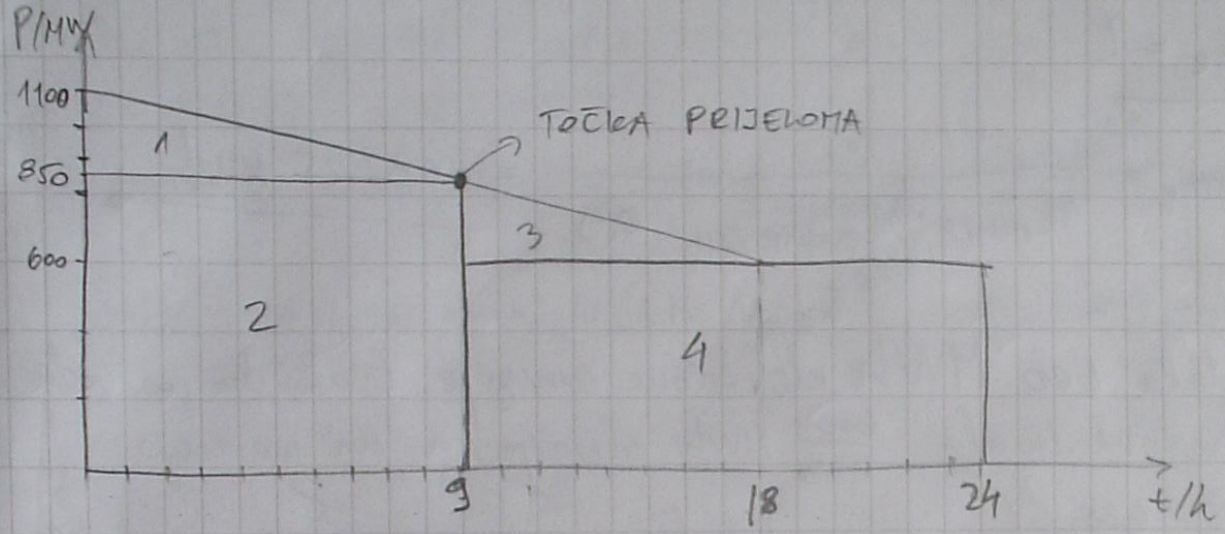
$\hookrightarrow P_v = 1100 - 600 = 500\ MW$

$T_v = 24 - 6 = 18\ h$

(6.) 1) $\alpha_1 = \beta_1 = 0.5$

2) $\alpha_2 + \beta_2 = 1.3$

$\frac{m_1}{m_2} = ?$



TOČKA PRIJELOMA

1) $(x, y) = (\alpha_1 T_v,\ P_k + \beta_1 \cdot P_v) = (9, 850)$

$W_1 = \underbrace{\frac{1}{2}(1100 - 850) \cdot 9}_{1} + \underbrace{850 \cdot 9}_{2} + \underbrace{\frac{1}{2}(850 - 600) \cdot 9}_{3} + \underbrace{600 \cdot 15}_{4} = 18900\ MWh$

2) $\alpha_2 + \beta_2 = 1.3$

$\alpha_2 + \beta_2 = 2 \cdot \frac{W_v}{T_v \cdot P_v} = 1.3 \rightarrow W_v = \frac{1}{2} \cdot 1.3 \cdot T_v \cdot P_v = \frac{1}{2} \cdot 1.3 \cdot 18 \cdot 500$

$W_v = 5850\ MWh$

$W_2 = W_k + W_v = 24 \cdot P_k + W_v = 20250\ MWh$

$$\frac{m_1}{m_2} = \frac{\frac{W_1}{W_{max}}}{\frac{W_2}{W_{max}}} = \frac{W_1}{W_2} = 0.9\dot{3}$$

(7) $P_{max} = 1100\ MW$. Ako sustav raspolaže samo sa termoelektranama snage 250 MW, potrebno ih je 5 za pokrivanje potrošnje

(8) EE, RHE

$W = 600\ MWh$

10% viene prelevato dal bacino

$\eta_{POMPA} = 0.7$

$\eta_{ELETTRICI} = 0.88$

$W_{POMPA,e} = ?$

$$W_{POMPA,e} = \frac{W}{\eta_{POMPA} \cdot \eta_{ELETTRICI} \cdot 0.9} = 1082.25\ MWh$$

⑨ NE

$e = 0.05$

SREDNJI ODGOR = 35000 $\frac{MWdana}{tU}$ – bova urana

$E = 210\ MeV$ po fisiji

Koji postotak jezgara U-235 je doživio fisiju?

- u jednoj toni urana ima $N_{U-235} = 0{,}05 \cdot 1000\,kg \cdot \frac{N_A}{235} = 1{,}28127 \cdot 10^{26}$ atoma
- sređuji odgor daje $\frac{35\,000 \cdot 24 \cdot 3600\ MJ}{210 \cdot 1{,}6 \cdot 10^{-19}\ MJ} = 9 \cdot 10^{25}$ atoma koji su doživjeli fisiju $\longrightarrow \frac{9 \cdot 10^{25}}{1.28127 \cdot 10^{26}} = 70.24\ \%$

(10) NE

$\eta = 15\% = 0.15$

$E = 5{,}68$ MeV po raspadu Pu^{238}

$m(PuC) = 200$ g

$T_{1/2} = 86$ godina

$W_e = ? \rightarrow t = 1$ god

udio Pu u PuC

u 200 g ima $N_0 = N_{Pu} = 200\,g \cdot \frac{238}{238+12} \cdot \frac{6.022 \cdot 10^{23}}{238} = 4{,}8$

nakon 1 godine ima $N(1) = N_0 e^{-\lambda \cdot 1} = 4{,}7789269 \cdot$

$$\lambda = \frac{\ln 2}{T_{1/2}}$$

$\rightarrow$ raspalo se $N(1) - N_0 = 3{,}8673078 \cdot 10^{21}$ atoma

$$W_e = \underbrace{N \cdot 5{,}68 \cdot 1{,}6 \cdot 10^{-19} \cdot \eta}_{[MJ]} \cdot \frac{1}{3600} \quad [MWh$$

$$J = W_s = \frac{Wh}{3600}$$

$$W_e = 146.625 \text{ kWh}$$

(11) BINARNA GEOTERMALNA TE, RANKINE

$\dot{m} = 210\ kg/s$

$P_{turbina} = 16.2\ MW$

$\dot{W}_{PUMPA} = -3.14\ kJ/kg$

$\dot{m}_{GV} = 800\ kg/s$ - geotermalna voda

$h_{GV} = 700\ kJ/kg$ - ulaz u postrojenje

$h_{GV} = 570\ kJ/kg$ - izlaz iz postrojenja

$$\eta_{TERMIČKI} = \frac{P_{turbina} - |\dot{W}_{PUMPA} \cdot \dot{m}|}{(h_{GV_{ulaz}} - h_{GV_{izlaz}}) \cdot \dot{m}_{GV}} = 0.149$$

(12) VE

$P = 1\ MW$

$D = 60\ m$ $\longrightarrow A = \frac{D^2\pi}{4}\ [m^2]$

$P_{VJETRA} = 1.1\ kW/m^2$ $\hookrightarrow P' = P_{VJETRA} \cdot A = 3,11\ MW$

$c_{pe} = ?$

$P = P' \cdot c_{pe} \rightarrow c_{pe} = 0,3215$

(13) VE - 100 MW $\rightarrow$ n = 50 vjetroagregata

$P_n = 2\ MW$

$m = 0,21$

$D = 90\ m$

$v = 11\ m/s$

$\rho = 1.225\ kg/m^3$

$W_{god.HEV} = 17000\ GWh$

$W_{god} = 100\ MW \cdot m \cdot 8760\ h \cdot \frac{1}{1000}\ [GWh]$

To je $\frac{W_{god}}{17000\ GWh} = 1,08\%$ godišnjih potreba Hrvatske.

(14) SUNCE, PARABOLIČNA PROTOČNA TE, $P_n = 100\,MW_e$, $W_{god\,Hrv} = 17\,000\,GWh$

$\eta = 0{,}15$

$W = 1600\ kWh/m^2$ - godišnja ozračenost

85% - udio direktne komponente sunčeva zračenja

35% - dobitak od praćenja Sunca

$950\ W/m^2$ – nazivna snaga pri otvoru ozračenja

Za $100\ MW_e$ treba nam površina $A = \dfrac{100\,MW_e}{\eta \cdot 950 \frac{W}{m^2}} = 701\,754{,}386\ m^2$

GODIŠNJA PROIZVODNJA ELEKTRIČNE ENERGIJE

$$W_{god} = \eta \cdot 1600 \frac{kWh}{m^2} \cdot 701\,754{,}386\ m^2 \cdot 1{,}35 \cdot 0{,}85$$

$$W_{god} = 193{,}26315\ GWh$$

To je $\dfrac{W_{god}}{17\,000\,GWh} = 1{,}14\%$ godišnjih potreba Hrvatske

(15) BIOMASA, $P_n = 100\,MW_e$, $W_{god\,Hrv} = 17\,000\,GWh$

$H = 11\ MJ/kg$ prinosa 15 t/ha godišnje

$\eta = 0.24$

$m = 0{,}87$

$$W_{god} = P_n \cdot m \cdot 8760 = 762{,}12\ GWh$$

To je $\dfrac{W_{god}}{17\,000\,GWh} = 4{,}48\%$ godišnjih potreba Hrvatske