ΘΕΜΑ 5 (Ιούνιος 2016)

Ψυγεία

Συντελεστής Λειτουργίας

$$COP_R = \frac{Q_L}{W_{net,in}} = \frac{\dot{Q}_L}{\dot{W}_{net,in}}$$

$\dot{Q}_L$ → επιθυμητή έξοδος

$\dot{W}_{net,in}$ → απαιτούμενη είσοδος

$$W_{net,in} = Q_H - Q_L$$

Αντλίες Θερμότητας

$$COP_{HP} = \frac{Q_H}{W_{net,in}} = \frac{\dot{Q}_H}{\dot{W}_{net,in}}$$

$\dot{W}_{net,in} = 430\ W$ $\quad COP_R = 2.4$

$\dot{Q}_L = (COP_R)\,\dot{W}_{net} = 2.4 \times 430\ W = 1032\ W$

$= 1032 \frac{J}{s} = 1.032 \frac{kJ}{s}$ Ρυθμός ψύξης

$Q = m C_p \Delta T$

$\Delta T = (15 - 6)^\circ C = 9^\circ C$

$C_p = 4.2 \frac{kJ}{kg^\circ C}$

$\rho = \frac{m}{V} \Rightarrow m = \rho V$

$V = 40\ lt$

$m = 1.0 \frac{kg}{lt}\ 40\ lt$

$m = 40\ kg$

$$Q = 40\,kg \times 4.2\,\frac{kJ}{kg\,^\circ C} \times 9\,^\circ C = 1512\,kJ$$ (2)

Τόσα πρέπει να αφαιρέσω από τα μπουκάλια

$$\Delta t = \frac{Q}{\dot{Q}_L} = \frac{1512\,kJ}{1.032\,\frac{kJ}{s}} = 1465\,s \xrightarrow{(\div 60)} = 24.4\,min$$

ΘΕΜΑ 3 (ΣΕΠΤ. 2015)

$\dot{W} = 200\,W = 200\,\frac{J}{s}$

$V = 50\,m^3$

$T_1 = 28\,^\circ C$

$\Delta t = 5\,h$

$T_2 = ;$

$$W = \dot{W}\Delta t = 200\,\frac{J}{s} \times 5 \times 3600\,s = 3600\,kJ$$

$$\left.\begin{aligned} Q &= m c_p \Delta T \\ \Delta T &= 28 - T_2 \\ \rho = \frac{m}{V} &\Rightarrow m = \rho V \end{aligned}\right\} Q = \rho V c_p (28 - T_2) = 3600\,kJ$$

$\vdots$

T_2

ΘΕΜΑ 4 (Ιούνιος 2016)

$$\dot{V} = 10\,lt/hr = 10\,\frac{10^{-3}\,m^3}{3600\,s} = 2.778\times10^{-6}\,m^3/s$$

$$\dot{W} = 25\,kW$$

$$\ominus.\,\Delta. = 50000\,kJ/kg$$

$$\rho = 0.8\,\frac{g}{cm^3} = 0.8\,\frac{10^{-3}\,kg}{(10^{-2}\,m)^3} = 800\,kg/m^3$$

$$\rho = \frac{m}{V} = \frac{\dot{m}}{\dot{V}} \Rightarrow \dot{m} = \rho\dot{V} = 800\,\frac{kg}{m^3}\times 2.778\times10^{-6}\,\frac{m^3}{s}$$

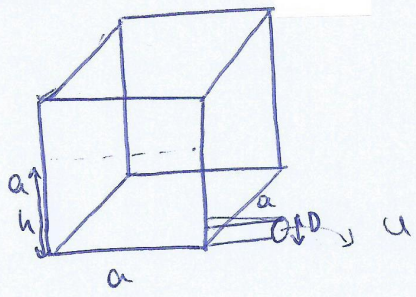
$$\dot{m} = 2.22\times10^{-3}\,kg/s$$

$$\dot{Q}_{in} = \dot{m}\times(\ominus.\Delta.) = 2.22\times10^{-3}\,\frac{kg}{s}\times 50000\,\frac{kJ}{kg}$$

$$\dot{Q}_{in} = 111.11\,\frac{kJ}{s} = 111.11\,kW$$

$$\eta_{th} = \frac{\dot{W}}{\dot{Q}_{in}} = \frac{25\,kW}{111.11\,kW} = 0.225 \text{ ή } 22.5\%$$

ΘΕΜΑ 2 (Ιαν. 2016)



$$\dot{m} = \frac{du}{dt}$$

$$\dot{m} = \rho u A_{\text{ουδ.}} = \rho (2gh)^{1/2} \cdot \frac{\pi D^2}{4} = \frac{\rho \pi D^2 \sqrt{2g}}{4} (h^{\frac{1}{2}})$$

$$m = \rho V = \rho a^2 \cdot h \qquad 0 \le h \le a$$

$$\frac{du}{dt} = \frac{d(\rho a^2 h)}{dt} = \rho a^2 \frac{dh}{dt} = \frac{\rho \pi D^2 \sqrt{2g}}{4} h^{\frac{1}{2}}$$

$$\int_0^t dt = \int_0^a \frac{4a^2\, dh}{\pi D^2 \sqrt{2g}\, h^{\frac{1}{2}}} = \frac{4a^2}{\pi D^2 \sqrt{2g}} \int_0^a \frac{dh}{h^{\frac{1}{2}}}$$

$$t = \frac{4a^2}{\pi D^2 \sqrt{2g}} \left[\frac{h^{-\frac{1}{2}+1}}{-\frac{1}{2}+1} \right]_0^a$$

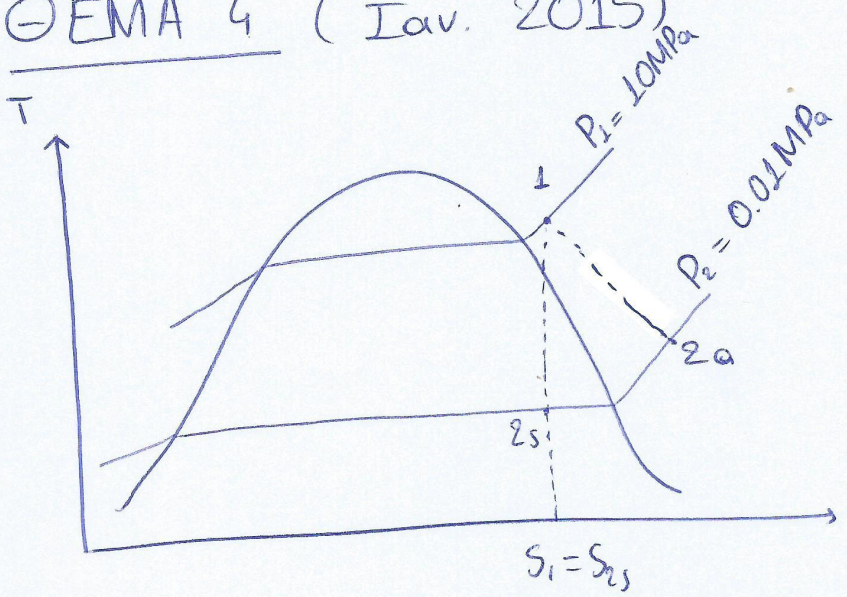
$$t = \frac{4a^2}{\pi D^2 \sqrt{2g}} \frac{h^{\frac{1}{2}}}{\frac{1}{2}} = \frac{8a^2 \sqrt{a}}{\pi D^2 \sqrt{2g}} \Rightarrow t = 1437.2\,s$$

$a = 1\,m$

$D = 2\,cm = 0.02\,m$

$g = 9.81\,m/s^2$

ΘΕΜΑ 4 (Ιαν. 2015)



$$\eta_T = \frac{h_1 - h_{2a}}{h_1 - h_{2s}}$$

$\eta_T = 0.8$

$1 \to 2s$ Ισεντροπική

$1 \to 2a$ Πραγματική

$P_1 = 10MPa$, $T_1 = 600°C$ $\Big\}$ Υπερθ. Νερού $\to$ $h_1 = 3625 kJ/kg$, $s_1 = 6.90 kJ/kgK$

$P_{2s} = 0.01MPa = 10kPa$, $s_{2s} = s_1$ $\Big\}$ $s_{2s} = s_f + x_{2s} s_{fg}$

$$x_{2s} = \frac{s_{2s} - s_f}{s_{fg}}$$

$s_f = s_{f@10kPa} = 0.65 kJ/kgK$

$s_{fg} = s_{fg@10kPa} = (s_g - s_f)_{@10kPa} = (8.15 - 0.65)\frac{kJ}{kgK}$

$s_{fg} = 7.5 \frac{kJ}{kgK}$

$$x_{2s} = \frac{6.9 - 0.65}{7.5} \Rightarrow x_{2s} = 0.83$$

$h_{2s} = h_f + x_{2s} h_{fg}$

$h_f = h_{f@10kPa} = 191.8 kJ/kg$

$h_{fg} = (h_g - h_f)_{@10kPa} = 2392.1 kJ/kg$

$\Big\}$ $h_{2s} = 2177.243 kJ/kg$

$$\eta_T = \frac{h_1 - h_{2a}}{h_1 - h_{2s}} \Rightarrow \eta_T (h_1 - h_{2s}) = h_1 - h_{2a}$$

$$h_{2a} = h_1 - \eta_T (h_1 - h_{2s}) = 2423.36 \text{ kJ/kg}$$

$$\dot{m} = 110 \frac{\text{kg}}{\text{min}} = \frac{110}{60} \frac{\text{kg}}{\text{s}}$$

$$\dot{m} = 1.83 \text{ kg/s}$$

Ενεργειακό Ισοζύγιο

$$\dot{E}_{in} = \dot{E}_{out}$$

$$\dot{m} h_1 = \dot{m} h_{2a} + \dot{W}_{out} \Rightarrow \dot{W}_{out} = 2199 \text{ kJ/kg}$$

$$\eta_{th} = \frac{\dot{W}_{out}}{\dot{m} h_1} = 0.33 \text{ ή } 33\%$$