problema 1

a)

$$Pot_{elect12} = pme \cdot cilind \cdot \frac{n}{2} \cdot \left| 0.016666667 \cdot \frac{s^{-1}}{min^{-1}} \right| \cdot \left| 100 \cdot \frac{kPa}{bar} \right| \cdot \eta_{gerad12} \cdot 2$$

$pme = 25$ [bar]

$$cilind = \pi \cdot \frac{0.46^2}{4} \cdot 0.56 \cdot 18 \ [m^3]$$

$n = 500$ [min^{-1}]

$\eta_{gerad12} = 0.97$

$$\eta_{mec} = \frac{Ne}{Ne + Np}$$

$Np = 3967$ [kW]

$$Ne = pme \cdot cilind \cdot \frac{n}{2} \cdot \left| 0.016666667 \cdot \frac{s^{-1}}{min^{-1}} \right| \cdot \left| 100 \cdot \frac{kPa}{bar} \right|$$

$$NeNt = \frac{Ne}{Nt} \cdot \left| 100 \cdot \frac{\%}{À} \right| \qquad Nt = \dot{Q}_{comb} \cdot \eta_{teórico} \qquad \dot{Q}_{comb} = \dot{m}_{comb} \cdot PCI$$

$$\eta_{teórico} = 1 - \left[\frac{1}{\varepsilon^{(\gamma - 1)}} \cdot \left(\frac{\delta^{\gamma} - 1}{\gamma \cdot [\delta - 1]} \right) \right]$$

$\dot{m}_{comb} = 0.893$ $\quad PCI = 43120$

$\varepsilon = 19$ $\quad \gamma = 1.4$ $\quad \delta = 1.2$

$$Ce = 3600 \ [s] \cdot \dot{m}_{comb} \cdot \frac{\left| 1000 \cdot \frac{g}{kg} \right|}{Ne \cdot 3600 \ [s] \cdot \left| 0.000277778 \cdot \frac{kWh}{kJ} \right|}$$

b

admitindo relação linear entre consumo e potência, método Willans line

$$\frac{\dot{m}_{comb}}{Ne + Np} = \frac{\dot{m}_{comb,vazio}}{Np}$$

c

$$\dot{Q}_{desgaseif} = \dot{m}_{prod} \cdot Cp_{prod} \cdot [T_B - T_C] \cdot 2$$

$$\dot{m}_{prod} = \dot{m}_{ar} + \dot{m}_{comb} \qquad \frac{AC_{esteq}}{\frac{\dot{m}_{ar}}{\dot{m}_{comb}}} = r \qquad r = 0.83 \qquad AC_{esteq} = 15.4$$

$T_B = 121.9$ $\quad T_C = 110$ $\quad Cp_{prod} = 1.34$

d

$$\dot{m}_{CO2} = y_{CO2} \cdot \dot{m}_{prod} \cdot 2$$

$$emiss_{CO2} = \dot{m}_{CO2} \cdot \frac{3600 \ [s]}{[Pot_{elect12} + Pot_{elect3}] \cdot 3600 \ [s] \cdot \left| 0.000277778 \cdot \frac{kWh}{kJ} \right|} \cdot \left| 1000 \cdot \frac{g}{kg} \right|$$

$$y_{CO2} = 0.141$$

e

$$\eta_{instal} = \left[\frac{Pot_{elect12} + Pot_{elect3} + \dot{Q}_{DE}}{\dot{m}_{comb} \cdot PCI \cdot 2} \right] \cdot \left| 100 \cdot \frac{\%}{\grave{A}} \right| \qquad \dot{Q}_{DE} = 1093$$

$$\dot{m}_{prod} \cdot 2 \cdot Cp_{prod} \cdot [T_A - T_C] + \dot{Q}_{1112} = \frac{Pot_{elect3}}{\eta_{gerad3}} + N_{perdas,Turbina} + \dot{Q}_{DE} + \dot{Q}_{condens}$$

$\eta_{gerad3} = 0.94$ $N_{perdas,Turbina} = 50$ [kW] $\dot{Q}_{condens} = \dot{m}_4 \cdot [h4 - h7]$

$\dot{m}_4 = 4.95$ [kg/s] $\dot{Q}_{1112} = 1831$

$h4 = \mathbf{h}['Steam_{IAPWS}', x=0.895, P=0.01228]$ $h7 = \mathbf{h}['Steam_{IAPWS}', x=0, P=0.01228]$

SOLUTION

Unit Settings: [kJ]/[C]/[bar]/[kg]/[degrees]

$AC_{esteq} = 15.4$	$Ce = 184.2$ [g/kWh]	$cilind = 1.675$ [m^3]
$Cp_{prod} = 1.34$ [kJ/kg·K]	$\delta = 1.2$	$emiss_{CO2} = 461.1$ [g/kWh]
$\varepsilon = 19$	$\eta_{gerad12} = 0.97$ [-]	$\eta_{gerad3} = 0.94$ [-]
$\eta_{instal} = 51.34$ [%]	$\eta_{mec} = 0.8148$ [-]	$\eta_{teórico} = 0.6802$ [-]
$\gamma = 1.4$	$h4 = 2259$ [kJ/kg]	$h7 = 42.02$ [kJ/kg]
$\dot{m}_4 = 4.95$ [kg/s]	$\dot{m}_{ar} = 16.57$ [kg/s]	$\dot{m}_{CO2} = 4.924$ [kg/s]
$\dot{m}_{comb} = 0.893$ [kg/s]	$\dot{m}_{comb,vazio} = 0.1654$ [kg/s]	$\dot{m}_{prod} = 17.46$ [kg/s]
$n = 500$ [min^{-1}]	$Ne = 17450$ [kW]	$NeNt = 66.63$ [%]
$Np = 3967$ [kW]	$Nt = 26191$ [kW]	$N_{perdas,Turbina} = 50$ [kW]
$PCI = 43120$ [kJ/kg]	$pme = 25$ [bar]	$Pot_{elect12} = 33853$ [kW]
$Pot_{elect3} = 4589$ [kW]	$\dot{Q}_{1112} = 1831$ [kW]	$\dot{Q}_{comb} = 38506$ [kW]
$\dot{Q}_{condens} = 10975$ [kW/dim]	$\dot{Q}_{DE} = 1093$ [kW]	$\dot{Q}_{desgaseif} = 556.9$ [kW]
$r = 0.83$	$T_A = 434.1$ [C]	$T_B = 121.9$ [C]
$T_C = 110$ [C]	$y_{CO2} = 0.141$	

No unit problems were detected.
EES suggested units (shown in purple) for h4 h7 m_dot_ar m_dot_CO2 Ne Pot_elect3 .

KEY VARIABLES

$Pot_{elect12} = 33853$ [kW]	*a)*
$\eta_{mec} = 0.8148$ [-]	*a) rendimento mecânico*
$NeNt = 66.63$ [%]	*a)*
$Ce = 184.2$ [g/kWh]	*a)*
$\dot{m}_{comb,vazio} = 0.1654$ [kg/s]	*b)*
$\dot{Q}_{desgaseif} = 556.9$ [kW]	*c)*
$emiss_{CO2} = 461.1$ [g/kWh]	*d)*
$\eta_{instal} = 51.34$ [%]	*e)*
$T_A = 434.1$ [C]	*e)*