

{Rankine cycle}

$$T[1]=1000$$

$$p[1]=2500$$

$$h[1]=\text{enthalpy}(\text{STEAM_NBS}, p=p[1], T=T[1])$$

$$s[1]=\text{entropy}(\text{STEAM_NBS}, p=p[1], T=T[1])$$

$$s[2]=s[1]$$

$$p[2]=1$$

$$T[2]=t_sat(\text{STEAM_NBS}, p=p[2])$$

$$h[2]=\text{enthalpy}(\text{STEAM_NBS}, p=p[2], s=s[2])$$

$$p[3]=p[2]$$

$$T[3]=T[2]$$

$$h[3]=\text{enthalpy}(\text{STEAM_NBS}, p=p[3], x=0)$$

$$s[3]=\text{entropy}(\text{STEAM_NBS}, p=p[3], x=0)$$

$$s[4]=s[3]$$

$$p[4]=p[1]$$

$$h[4]=\text{enthalpy}(\text{STEAM_NBS}, p=p[4], s=s[4])$$

$$T[4]=\text{temperature}(\text{STEAM_NBS}, p=p[4], s=s[4])$$

{states 5-7 are only there for plotting}

$$T[5]=t_sat(\text{STEAM_NBS}, p=p[1])$$

$$T[6]=T[5]$$

$$T[7]=T[1]$$

$$h[5]=\text{enthalpy}(\text{STEAM_NBS}, p=p[1], x=0)$$

$$h[6]=\text{enthalpy}(\text{STEAM_NBS}, p=p[1], x=1)$$

$$h[7]=h[1]$$

$$m_dot_s=2.4e6$$

$$Wt=h[1]-h[2]$$

$$Wp=h[3]-h[4]$$

$$P=m_dot_s*(Wt+Wp)/K1$$

$$K1=3.413e6$$

$$\eta_{th}=(Wt+Wp)/(h[1]-h[4])$$

$$q_out=m_dot_s*(h[2]-h[3])$$

{heat exchanger calculations}

$$Tw2_assumed=T[2]-8$$

$$Tw[3]=70$$

$$LMTD=((T[3]-Tw[3])-(T[2]-Tw2_assumed))/(\ln(T[3]-Tw[3])-\ln(T[2]-Tw2_assumed))$$

{using the nomenclature of the book}

$$U=C1*C2*C3*C4*V^{.5}$$

$$C1=263$$

$$C2=1$$

$$C3=0.58$$

$$C4=0.85$$

$$V=7$$

$$q_out=U*A*LMTD$$

$$A_tube=\pi*D*L$$

$$D=7/8/12$$

$$L=45$$

$$n=A/A_tube$$

{compare delta T of water from energy balance with that initially assumed, solution shows they are close}

{mass flow water = rho*V*A, A = Ac*n/2 for two pass water flow area is that of n/2 tubes}

{Tube flow area}

$$ID=0.777 \text{ {from text appendix K}}$$

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Ac=pi*(ID/12)^2/4
rho_w=density(STEAM_NBS,p=14.7,T=Tav)
m_dot_w=n/2*rho_w*V*Ac*K2
K2=3600
Cp_w=specheat(STEAM_NBS,T=Tav,P=14.7)
Tav=(Tw[2]+Tw[3])/2
DT=q_out/(Cp_w*m_dot_w)
DT_assumed=Tw2_assumed-Tw[3]

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{for plotting on T-Q or T-h diagram}

Tw[2]=T[2]-8

SOLUTION

Unit Settings: [F]/[psia]/[lbm]/[degrees]

A = 317971 [ft ²]	Ac = 0.003293 [ft ²]	A _{tube} = 10.31 [ft ²]
C1 = 263 [Btu/(hr-ft ² -F)/(ft/s) ⁻⁵]	C2 = 1 [-]	C3 = 0.58 [-]
C4 = 0.85 [-]	Cp _w = 0.9991 [Btu/lbm-F]	D = 0.07292 [ft]
DT = 23.61 [F]	DT _{assumed} = 23.71 [F]	η _{th} = 0.4331 [-]
ID = 0.777 [ft]	K1 = 3.413E+06 [btu/(MW-hr)]	K2 = 3600 [s/hr]
L = 45 [ft]	LMTD = 17.22 [F]	m _s = 2.400E+06 [lbm/hr]
m _w = 7.960E+07 [lbm/hr]	n = 30846 [-]	P = 420.4 [MW]
q _{out} = 1.878E+09 [btu/hr]	ρ _w = 62.2 [lb _m /ft ³]	Tav = 81.85 [F]
Tw2 _{assumed} = 93.71 [F]	U = 343 [btu/(ft ² -hr-F)]	V = 7 [ft/s]
Wp = -7.435 [Btu/lb _m]	Wt = 605.2 [btu/lb _m]	

No unit problems were detected.

Purple units were automatically set. Right click on the variable to confirm or change the units.

