

"Turbo HW5"

"Zhaoyi Jiang (.1364)"

"Problem 2"

"Given"

$u=250[\text{m/s}]$

$\phi=0.42$

$\psi=0.32$

$\alpha_1=5[\text{degree}]$

$p_1=1[\text{bar}]$

$t_1=300[\text{K}]$

"degree of R"

$\tan(\alpha_1)=(1-R-\psi/2)/\phi$

"Velocity triangles"

$\tan(\alpha_2)=(1-R+\psi/2)/\phi$

$\tan(\beta_1)=-(R+\psi/2)/\phi$

$\tan(\beta_2)=-(R-\psi/2)/\phi$

$u=c_z*(\tan(\alpha_1)-\tan(\beta_1))$

$w_1=c_z/\cos(\beta_1)$

$w_2=c_z/\cos(\beta_2)$

$c_1=c_z/\cos(\alpha_1)$

$c_2=c_z/\cos(\alpha_2)$

$W=u*(c_2*\sin(\alpha_2)-c_1*\sin(\alpha_1))*\text{convert}(\text{J},\text{kJ})$

$c_3=c_1$

"zetas"

$\text{zeta}_r=0.04+0.06*((\beta_2-\beta_1)/100[\text{deg}])^2$

$\text{zeta}_s=0.04+0.06*((\alpha_2-\alpha_1)/100[\text{deg}])^2$

"Thermal analysis"

$h_1=\text{enthalpy}(\text{air},t=t_1)$

$s_1=\text{entropy}(\text{air},t=t_1,p=p_1)$

$h_{01}=h_1+0.5*c_1^2*\text{convert}(\text{J},\text{kJ})$

$t_{01}=\text{temperature}(\text{air},h=h_{01})$

$p_{01}=\text{pressure}(\text{air},s=s_1,h=h_{01})$

$h_{r1}=h_1+0.5*w_1^2*\text{convert}(\text{J},\text{kJ})$

$h_2=h_{r1}-0.5*w_2^2*\text{convert}(\text{J},\text{kJ})$

$h_{2s}=h_2-\text{zeta}_r*0.5*w_2^2*\text{convert}(\text{J},\text{kJ})$

$s_{2s}=s_1$

$p_2=\text{pressure}(\text{air},s=s_{2s},h=h_{2s})$

$t_2=\text{temperature}(\text{air},h=h_2)$

$s_2=\text{entropy}(\text{air},p=p_2,t=t_2)$

$s_{3s}=s_2$

$h_{02}=h_2+0.5*c_2^2*\text{convert}(\text{J},\text{kJ})$

$h_{02}=h_{03}$

$h_3=h_{03}-0.5*c_3^2*\text{convert}(\text{J},\text{kJ})$

$h_{3s}=h_3-0.5*\text{zeta}_s*c_3^2*\text{convert}(\text{J},\text{kJ})$

$p_3=\text{pressure}(\text{air},s=s_{3s},h=h_{3s})$

$t_3=\text{temperature}(\text{air},h=h_3)$

$s_3=\text{entropy}(\text{air},h=h_3,p=p_3)$

$p_{03}=\text{pressure}(\text{air},h=h_{03},s=s_3)$

$h_{03ss}=\text{enthalpy}(\text{air},s=s_1,p=p_{03})$

$\text{Ratio}=p_{03}/p_{01}$

$\eta_{tt}=(h_{03ss}-h_{01})/(h_{03}-h_{01})$

SOLUTION

**Unit Settings: SI K bar kJ mass deg**

$\alpha_1 = 5 \text{ [Degree]}$

$\beta_1 = -66.44 \text{ [degree]}$

$c_1 = 105.4 \text{ [m/s]}$

$c_3 = 105.4 \text{ [m/s]}$

$\eta_{tt} = 0.9481$

$h_{02} = 326 \text{ [kJ/kg]}$

$h_{03ss} = 325 \text{ [kJ/kg]}$

$h_2 = 316.5 \text{ [kJ/kg]}$

$h_3 = 320.4 \text{ [kJ/kg]}$

$h_{r1} = 335 \text{ [kJ/kg]}$

$p_{03} = 1.315 \text{ [bar]}$

$p_2 = 1.19 \text{ [bar]}$

$\phi = 0.42$

$R = 0.8033$

$s_1 = 5.706 \text{ [kJ/kg-K]}$

$s_{2s} = 5.706 \text{ [kJ/kg-K]}$

$s_{3s} = 5.708 \text{ [kJ/kg-K]}$

$t_1 = 300 \text{ [K]}$

$t_3 = 319.9 \text{ [K]}$

$W = 20 \text{ [kJ/kg]}$

$w_2 = 192.1 \text{ [m/s]}$

$\zeta_s = 0.0475$

$\alpha_2 = 40.34 \text{ [degree]}$

$\beta_2 = -56.86 \text{ [degree]}$

$c_2 = 137.8 \text{ [m/s]}$

$c_z = 105 \text{ [m/s]}$

$h_{01} = 306 \text{ [kJ/kg]}$

$h_{03} = 326 \text{ [kJ/kg]}$

$h_1 = 300.4 \text{ [kJ/kg]}$

$h_{2s} = 315.8 \text{ [kJ/kg]}$

$h_{3s} = 320.2 \text{ [kJ/kg]}$

$p_{01} = 1.066 \text{ [bar]}$

$p_1 = 1 \text{ [bar]}$

$p_3 = 1.239 \text{ [bar]}$

$\psi = 0.32$

$\text{Ratio} = 1.234$

$s_2 = 5.708 \text{ [kJ/kg-K]}$

$s_3 = 5.709 \text{ [kJ/kg-K]}$

$t_{01} = 305.5 \text{ [K]}$

$t_2 = 316 \text{ [K]}$

$u = 250 \text{ [m/s]}$

$w_1 = 262.7 \text{ [m/s]}$

$\zeta_r = 0.04055$

No unit problems were detected.