Textbook Reading 6.11-6.13

HW – 30

Air steadily enters a well-insulated turbine at an absolute pressure of 6.75 bar and an absolute temperature of 1600 K with negligible velocity (State 1) and exits at an absolute pressure of 2.3 bar and an absolute temperature of 1340 K with negligible velocity (State 2). Air then enters an adiabatic, rigid nozzle and exits an absolute pressure of 0.23 bar with a velocity of 1150 m/s (State 3). Use air tables that consider variable specific heats.

(a) Find the specific entropy generation for the turbine, in kJ/kg-K.
(b) Calculate the isentropic efficiency of the turbine, in %.
(c) Determine the specific entropy generation for the nozzle, in kJ/kg-K.
(d) Calculate the isentropic efficiency of the nozzle, in %.
(e) Show the two processes on *T-s* diagram relative to the appropriate lines of constant pressure. Label actual and isentropic states and identify process directions with arrows.

HW – 31(i)

Saturated liquid water at an absolute pressure of 1 bar (State 1) is compressed at steady state to an absolute pressure of 25 bar (State 2) using an adiabatic pump with an isentropic efficiency of 85%. Use compressed liquid tables.

(a) Determine the specific work for the pump, in kJ/kg.
(b) Find the specific entropy generation for the pump, in kJ/kg-K.
(c) Show the process on *T-s* diagram relative to the vapor dome and the appropriate lines of constant pressure. Label actual and isentropic states and identify process direction with arrows. For water: $P_{critical}$ = 221 bar and $T_{critical}$ = 374°C.

HW – 31(ii)

Saturated water vapor at an absolute pressure of 1 bar (State 1) is compressed at steady state to an absolute pressure of 25 bar (State 2) using an adiabatic compressor with an isentropic efficiency of 85%.

(a) Determine the specific work for the compressor, in kJ/kg.
(b) Find the specific entropy generation for the compressor, in kJ/kg-K.
(c) Show the process on *T-s* diagram relative to the vapor dome and the appropriate lines of constant pressure. Label actual and isentropic states and identify process direction with arrows. For water: $P_{critical}$ = 221 bar and $T_{critical}$ = 374°C.

HW – 32

Air with a mass flow rate of 1.5 kg/s expands from an absolute pressure of 11.75 bar and an absolute temperature of 1500 K (State 1) in a turbine operating at steady state to an absolute pressure of 1 bar (State 2) via an internally reversible polytropic process $Pv^{1.3}$ = constant. Assume that there is heat transfer to the turbine from the surroundings at an absolute temperature of 2000 K. Use air tables that consider variable specific heats.

(a) Determine the power output of the turbine, in kW.
(b) Find the rate of heat transfer for the turbine, in kW.
(c) Calculate the rate of total entropy generation for the turbine and its interaction with its surroundings, in kW/K.
(d) Show the process on *T-s* diagram relative to the appropriate lines of constant pressure. Label states and identify process direction with arrows.