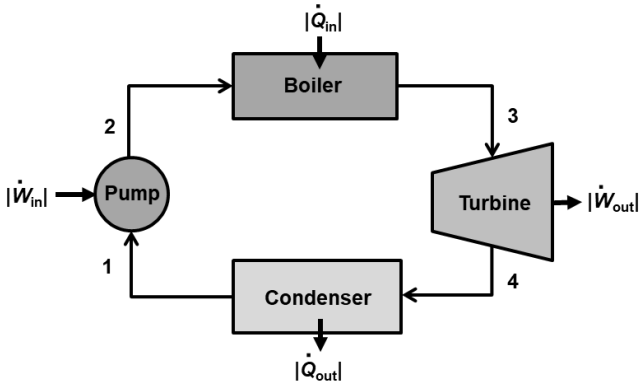
HW – 33: Rankine Cycles

i) A proposed ideal Rankine cycle is operating at steady state between pressures of 10 bar and 0.02 bar with water as the working fluid. The inlet to the adiabatic turbine is a saturated vapor and the inlet to the adiabatic pump is a saturated liquid. Neglect changes in kinetic and potential energies for all components. If all processes are reversible, determine the net work output per unit mass for this cycle and the cycle thermal efficiency. Sketch the *T*-*s* diagram for this cycle.



ii) To increase the cycle efficiency, an alternate Rankine cycle (termed a Carnot Rankine cycle) operating between the same pressures of 10 bar and 0.02 bar is proposed. The inlet to the adiabatic turbine is a saturated vapor. For this Carnot Rankine cycle, the exit from the adiabatic pump is a saturated liquid. Neglect changes in kinetic and potential energies for all components. If all processes are reversible, determine the net work output per unit mass for this cycle and the cycle thermal efficiency. Sketch the *T*-*s* diagram for this cycle. Compare this efficiency to the Carnot efficiency, and comment on the advantages and disadvantages of this cycle.

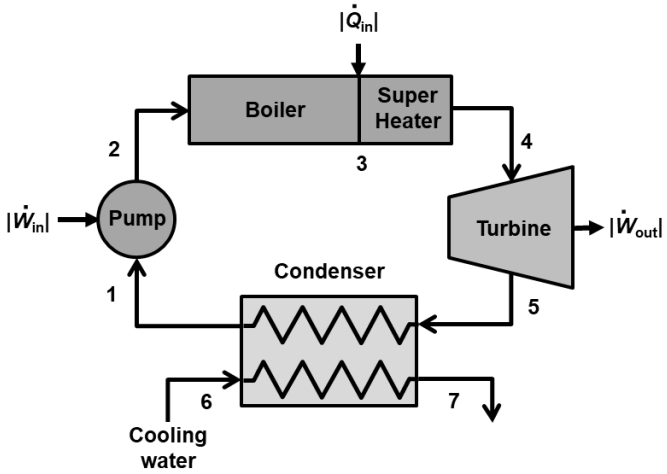
iii) Repeat i) with the turbine and pump isentropic efficiencies of 0.80. Determine the states 2 and 4, the net work output per unit mass for this cycle, and the cycle thermal efficiency. Sketch the *T*-*s* diagram for this case.

HW – 34: Rankine Cycle with Superheat

The system diagram shows a Rankine vapor power plant operating at steady state with water as the working fluid. Data at key locations are given in the table. The plant is designed to produce 120 MW. Changes in kinetic and potential energies can be ignored. Determine:

(a) the mass flow of water in the cycle, in kg/s.
(b) the thermal efficiency of the cycle.
(c) the isentropic turbine efficiency.
(d) the mass flow rate of the cooling water, in kg/s.
(e) the rates of entropy production, each in kW/K, for the turbine, condenser, and pump.

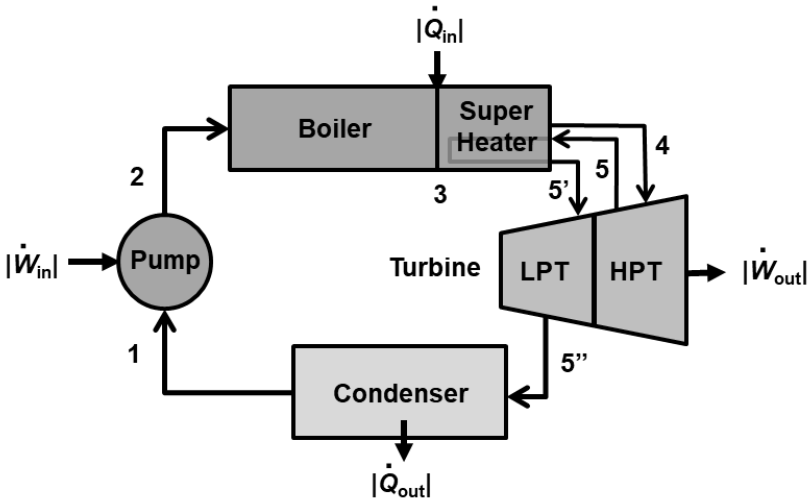
Sketch the *T*-*s* diagram for the cycle.



State	*P* [bar]	*T* [°C]	*x*	*h* [kJ/kg]	*s* [kJ/(kgK)]
1	0.08		0.00	173.84	0.59249
2	100.0	43		188.85	0.60605
3	100.0				
4	100.0	520		3426.4	6.6649
5	0.08		0.90		
6	1.0	20		84.01	0.296480
7	1.0	35		146.72	0.505130

HW – 35: Rankine Cycle with Reheat

Compare the Rankine cycle with superheat in HW 34 to this Rankine cycle with reheat. The reheat cycle operates with the same mass flow rate, boiler, superheater, and condenser conditions as in HW 34. In the reheat cycle, steam leaves the high-pressure stage of a two-stage turbine at 500 kPa, is reheated to 520°C, and then is fed to the low-pressure turbine stage. Assume that both turbine stages have efficiencies of 81.3 %. The state data for the reheat cycle are noted in the table. Determine the net work output per unit mass and thermal efficiency of the reheat cycle. Compare these results with the net work per unit mass and thermal efficiency for the Rankine superheat cycle in HW 34. Draw the *T-s* diagram for the reheat cycle.



State	*P* [bar]	*T* [°C]	*x*	*h* [kJ/kg]	*s* [kJ/(kgK)]
1	0.08		0.00	173.84	0.59249
2	100.0	43		188.85	0.60605
3	100.0				
4	100.0	520		3426.4	6.6649
5	5.0				
5'	5.0	520			
5''	0.08				