Statement

One-tenth kilogram of water executes a Carnot power cycle. At the beginning of the isothermal expansion, the water is a saturated liquid at 160° C. The isothermal expansion continues until the quality is 98%. The temperature at the conclusion of the adiabatic expansion is 20° C.

(a) Sketch the cycle on T-s and p-v coordinates.

(b) Determine the heat added and net work, each in kJ.

(c) Evaluate the thermal efficiency.

Solution Part a



Solution

• Part (b) $Q_{12}=_{1} \int {}^{2}Tds = mT_{1}(s_{2}-s_{1})$ $Q_{34}=_{3} \int {}^{4}Tds = mT_{3}(s_{4}-s_{3}) = -mT_{1}(s_{2}-s_{1})$ $Q_{23}=Q_{41}=0$ For any cycle $W_{cycle}=Q_{cycle}$ $W_{cycle}=m[T_{1}(s_{2}-s_{1})-T_{3}(s_{2}-s_{1})]$ $W_{cycle}=m(T_{1}-T_{3})(s_{2}-s_{1})$ • Part(b) For calculating s_2 use quality formula $S_2=s_1+x(s_g-s_1)$ By using temperature table for properties of saturated water $S_2=1.9427+0.98(6.7502-1.9427)=6.654kj/kg.K$ $Q_{12}=0.1*433*(6.654-1.9427)=203.99kJ$ $W_{cycle}=0.1*140*(6.654-1.9427)=65.96kJ$

Part(c)
 η=W_{cycle}/Q₁₂
 η=65.96/203.99=0.323=32%