Quiz # 1 (15 minutes, 5points)

4.5

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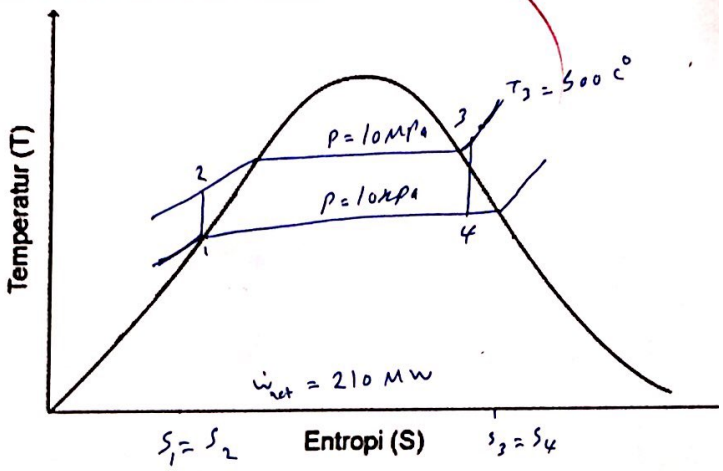
Consider a 210 MW steam power plant that operates on a simple ideal Rankine cycle. Steam enters the turbine at 10 *MPa* and 500°C and is cooled in the condenser to a pressure of 10 *kpa*. Show the cycle on a T – s diagram, Then **Determine:** (a)the quality of steam at the turbine exit, (b)the thermal efficiency of the cycle, and (c) the mass flow rate of the steam.



State (1) Sat. Liquid

$P = 10kPa$

$v = 0.00101\ m^3/kg$

$h_f = 191.8\ kJ/kg$

$h_g = 2583.9\ kJ/kg$

$h_{fg} = 23921\ kJ/kg$

State (2)

$h_2 = h_1 + w\, v_1 [P_2 - P_1]$

$= 191.8 + 0.00101[10\times10^3 - 10]$

$= 201.8\ kJ/kg$

$w_p = 10.08\ kJ/kg$

State (3) S.H.V

$h_3 = 3375.1\ kJ/kg$

$s_3 = 6.5995\ kJ/kg.K$

State (4) Mixture

$s_4 = s_3 = 6.5995\ kJ/kg.K$

$x_4 = \dfrac{s_4 - s_f}{s_{fg}} = \dfrac{6.5995 - 0.6492}{7.499}$

$= 0.79$

$h_4 = h_{f_1} + x\, h_{fg}$

$= 191.8 + (0.79(23921))$

$= 2081.5\ kJ/kg$

$q_{in} = h_3 - h_2$

$= 3375.1 - 201.8$

$= 3173.3\ kJ/kg$

$q_{out} = h_4 - h_1$

$= 2089.5 - 191.8$

$= 1889.7\ kJ/kg$

$\eta_{th} = 1 - \dfrac{q_{out}}{q_{in}}$

$= 1 - \dfrac{1889.7}{3173.3}$

$= 0.404$

$= 40\%$

$w_{net} = h_3 - h_4$

$= 1293.6\ kJ/kg$

$\dot{m}_{SG} = \dfrac{\dot{w}_T}{w_{net}}$

$= \dfrac{210\,000}{1293.6} = 162.3$

$\approx 164\ kg/s$