ÇANKAYA UNIVERSITY

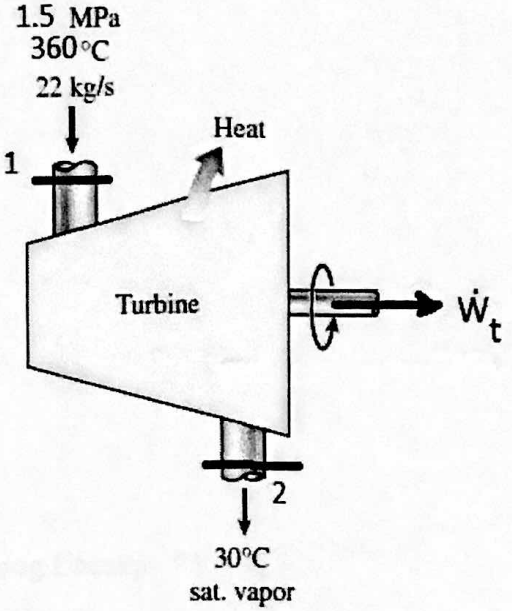
DEPARTMENT OF MECHANICAL ENGINEERING

ME211 THERMODYNAMICS I

Quiz on CH 4

Fall 2016

A steam turbine operates with 1.5 MPa and 360 ^{0}C steam at its inlet and saturated vapor at 30 ^{0}C at its exit. The mass flow rate of the steam is 22 kg/s, and the turbine produces 12,350 kW of power. Determine the rate at which heat is lost through the casing of this turbine.



State 1:

1,5 MPa = 15 bar

360 °C

$h_1 = 3169,2$ kJ/kg

State 2:

30°C sat vap

$h_2 = 2556.3$ kJ/kg

$\dot{m} = 22$ kg/s

$\dot{W}_t = 12350$ kW

Energy balance:

$$\frac{dE_{cv}}{dt} = \dot{Q}_{cv} - \dot{W}_{cv} + \dot{m}_i\left(h_i + \frac{V_i^2}{2} + gz_i\right) - \dot{m}_e\left(h_e + \frac{V_e^2}{2} + gz_e\right)$$

(no KE, no PE, no KE, no PE)

0 (Steady) $\quad (\dot{m}_i = \dot{m}_e = \dot{m})$

$$\Rightarrow 0 = \dot{Q}_{cv} - \dot{W}_{cv} + \dot{m}(h_i - h_e)$$

$$\Rightarrow \dot{W}_t = \dot{Q}_{cv} + \dot{m}(h_1 - h_2)$$

$$\Rightarrow 12350 = \dot{Q}_{cv} + 22(3169,2 - 2556,3)$$

$$\Rightarrow \dot{Q}_{cv} = 12350 - 13483.8$$

$$\Rightarrow \boxed{\dot{Q}_{cv} = -1133,8 \text{ kW}}$$