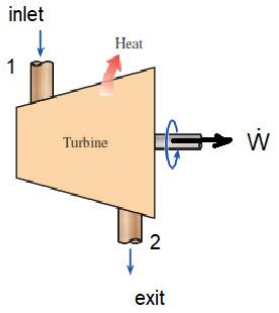
**Cankaya University**
**Faculty of Engineering**
**Mechanical Engineering Department**
**Me 211 Thermodsynamics I**
**Quiz # 4 Fall 2017- SOLUTION**

**In order to get partial credit show steps of all your work and do not forget units.**

A steam turbine operates with 1.5 MPa and 350°C steam at its inlet and saturated vapor at 30°C at its exit. The mass flow rate of the steam is 16 kg/s, and the turbine produces 9000 kW of power. Determine the rate at which heat is lost through the casing of this turbine. Show the p-v diagram with respect to saturation lines.




State 1

$P_1 = 1.5\ MPa = 15\ bar$, $T_1 = 350°C$ ) Table A.4.

320°C → h = 3081,9 kJ/kg
350°C → $h_1$ = ?
360°C → h = 3169,2 kJ/kg

$$\frac{360-350}{360-320} = \frac{3169,2-h_1}{3169,2-3081,9} \Rightarrow h_1 = 3147.38\ kJ/kg.$$

State 2

$T_2 = 30°C$, saturated vapor.

Table A.2 $h_g = 2556,3\ kJ/kg$.

$$0 = \dot{Q} - \dot{W}_T + \dot{m}_1\left(h_1 + \frac{V_1^2}{2} + gz_1\right) - \dot{m}_2\left(h_2 + \frac{V_2^2}{2} + gz_2\right)$$

mass balance: $\dot{m}_1 = \dot{m}_2 = 16\ kg/s$.

$$\Rightarrow 0 = \dot{Q}_{cv} - \dot{W}_T + \dot{m}(h_1 - h_2)$$

$\dot{W}_T = 9000\ kW$.

$$\Rightarrow 0 = \dot{Q}_{cv} - 9000 + 16(3147,38 - 2556,3)$$

$$\Rightarrow \dot{Q}_{cv} = 9000 - 9457,28 = -457,28\ kW$$

$$\Rightarrow \boxed{\dot{Q}_{cv} = -457,28\ kW}$$ heat is lost to surroundings.