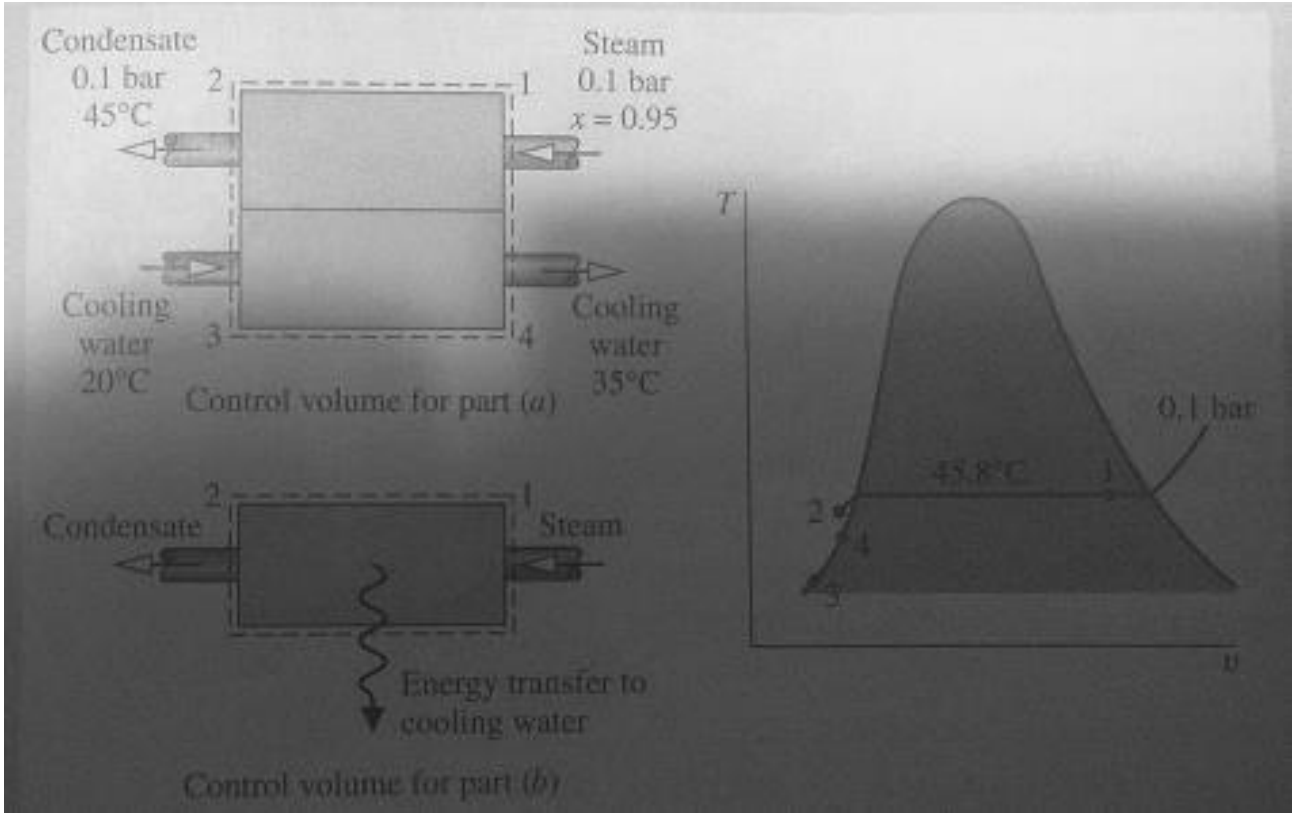
Statement

- **Steam enters** the condenser of a vapor power plant at **0.1 bar with a quality of 0.95** and **condensate exits at 0.1 bar and 45 degree Celsius**. **Cooling water enters the condenser in a separate stream** as a liquid at **20 degree Celsius and exits as a liquid at 35 degree Celsius** with no **change in pressure**. *Heat transfer* ***from the outside of the condenser*** *and changes in the kinetic and potential energies of the flowing streams can be ignored*. For steady-state operation, determine: a) the ratio of the *mass flow rate of the cooling water to the mass flow rate of the condensing steam*. b) *the rate of energy transfer from the condensing steam to the cooling water,in kJ per kg of steam passing through the condenser*.

Figure


Condensate
0.1 bar
45°C
2
1
Steam
0.1 bar
x = 0.95
Cooling water 20°C
3
4
Cooling water 35°C
Control volume for part (a)
2
1
Condensate
Steam
Energy transfer to cooling water
Control volume for part (b)
T
0.1 bar
45.8°C
1
2
4
3
v

Solution

- Write the mass balance

$\dot{m}_1 = \dot{m}_2$ (for steam)

$\dot{m}_3 = \dot{m}_4$ (for cooling water)

Write energy rate balance equation for the control volume and modify according to the given information.

$$\frac{dE_{cv}}{dt} = \dot{Q}_{cv} - \dot{W}_{cv} + \dot{m}_1\left(h_1 + \frac{{V_1}^2}{2} + gz_1\right) - \dot{m}_2\left(h_2 + \frac{{V_2}^2}{2} +\right.$$

$\dot{m}_1(h_1) - \dot{m}_1(h_2) + \dot{m}_3(h_3) - \dot{m}_3(h_4) = 0$

Find enthalpies (*you can use X-steam excel sheet*)

h1 = 0.95*2583.9+(1-0.95)*191.8=2464.295 kJ/kg

h2=hf(45 degree celsius)=188.4kJ/kg

h3=hf(20 degree celsius)=83.9kJ/kg

h4=hf(35 degree celsius)=146.6kJ/kg

Solution

- ***Plug the values of enthalpy and find the answer yourself and email me the results.***
- ***Last part do it yourself considering half control volume (steam side) and writing the energy rate balance and email me the results.***