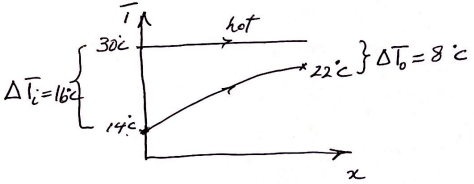
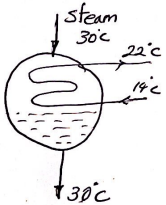
Example: Heat Exchangers (LMTD Method)

Steam in a condenser of a power plant is condensed at 30 °C by cold water supplied from a lake. Cold water at temperature of 14 °C enters the condenser and leaves at 22 °C. The surface area of the tubes is 45 m^2 and overall heat transfer coefficient is 2100 $W/m^2.°C$. Determine the mass flow rate of water and the mass flow rate of condensate steam.





$$\Delta T_{lm} = \frac{\Delta T_i - \Delta T_o}{\ln \frac{\Delta T_i}{\Delta T_o}} = \frac{16-8}{\ln 16/8} = 11.5\,^{\circ}c$$

$$\Delta T_{av} = \frac{1}{2}\left(\Delta T_1 + \Delta T_2\right) = \frac{1}{2}(16+8) = 12\,^{\circ}c$$

$$q = \dot{m}_c\, C_{p,c}\left(T_{c,o} - T_{c,i}\right)$$

$$q = UA\Delta T_{lm} \Rightarrow q = 2100 \times 45\,(11.5) = 1{,}086{,}750\ W$$

$$\text{water}\quad \dot{m}_c = \frac{q}{C_{p,c}(T_{c,o} - T_{c,i})} = \frac{1086750}{4180(22-14)} = 32.5\ kg/s$$

$$\text{steam} \rightarrow q = \dot{m}_s h_{fg} \Rightarrow \dot{m}_s = \frac{q}{h_{fg\,@30^{\circ}c}} = \frac{1086750\ W(J/s)}{2430.5\times10^3\ J/kg} = 0.45\ kg/s$$

0.45 kg steam — 32.5 kg/s of water

x — 1

x = 72 kg of water required to condensate 1 kg of steam.