**Examples (condenser)**

**Example (6.2)** Surface condenser is used to handle 10,000 kg of steam per hour. The steam enters at 0.1 bar and 0.9 dryness and condensate leave at the corresponding saturation temperature. The pressure is constant through the condenser. Estimate the cooling water flow rate per hour, if the cooling water temperature rise is limited to 10°C.

Solution: Given; $m_s = 10{,}000\ kg/h\,; P = 0.1\ bar; x = 0.9;\ \Delta T_{water} = 10°\mathrm{C}$

$C_{pw} = 4.2\ kj/kg.K\ ;\ m_{water} = ?$

From saturated steam tables:

$@P = 0.1\ bar \rightarrow h_f = 191.81\ \&\ h_g = 2583.9\ kj/kg$

$h = h_f + x(h_g - h_f) = 191.81 + 0.9(2583.9 - 191.81)$

$h = 2344.7\ kj/kg$

$Q_{lost} = Q_{gained}$

$m_s^o \times (h - h_f) = m_w^o \times C_{pw} \times (\Delta T_{water})$

$10000 \times [(2344.7 - 191.81) \times 10^3] = m_w^o \times (4.2 \times 10^3) \times (10)$

$m_w^o = \frac{21528.9\times10^6}{42\times10^3} \rightarrow m_w^o = 512.593 \times 10^3\ kg/h\ of\ cooling\ water$

**Example (6.3)** The steam is supplied to a steam turbine. The condenser pressure is 0.1 bar. If the plant capacity is 120MW and the specific steam consumption is 4 kg/kWh. Determine the cooling water required per hour in the condenser. If quality of steam exhausted from the turbine is 75% and the rise in temperature in cooling water is limit to 10°C.

Solution:

Given; $m_s = 4\ kg/kW.h\,;\ P = 0.1\ bar\,; X = 0.75$

$Power_{turbine} = 120\ MW;\ \Delta T_{water} = 10°\mathrm{C};\ C_{pw} = 4.2\ kj/kg.K$

$m_{water} = ?$

From saturated steam tables:

$@P = 0.1\ bar\ \rightarrow\ h_f = 191.81\ \&\ h_g = 2583.9\ kj/kg$

$h = h_f + x(h_g - h_f) = 191.81 + 0.75(2583.9 - 191.81)$

$h = 1985.9\ kj/kg$

$m_s^o = 4\frac{kg}{kW.h} \times \frac{1}{3600}\left(\frac{h}{s}\right) = \frac{4}{3600}\left(\frac{kg}{kW.s}\right)$

$m_s^o = \frac{4}{3600}\left(\frac{kg}{kW.s}\right) \times (120 \times 10^3 kW) = \left(\frac{480\times10^3}{3600}\right)\frac{kg}{s} = 133.3\frac{kg}{s}$

$Q_{lost} = Q_{gained}$

$m_s^o \times (h - h_f) = m_w^o \times C_{pw} \times (\Delta T_{water})$

$133.3 \times [(1985.9 - 191.81) \times 10^3] = m_w^o \times (4.2 \times 10^3) \times (10)$

$m_w^o = \frac{239149}{42} \rightarrow m_w^o = 5694\ kg/s\ of\ cooling\ water$

$m_w^o = 5694 \times 3600 = 20{,}498\ \ ton/h\ of\ cooling\ water$