Answer on Question #77748-Engineering- Material Science Engineering

A heat exchanger produces dry steam at 100 C from feed water at 30C at a rate of 1.5 kgs^-1. The heat exchanger receives heat energy at a rate of 600 kW from the fuel used. The specific heat capacity of water is 4187 Jkg^-1K^-1 and its specific latent heat of vaporisation is 2257000 Jkg^-1.

A) Determine the heat energy received per kilogram of steam produced.

B) Determine the output power of the heat exchanger and its thermal efficiency.

Solution

$$\frac{dm}{dt} = 1.5\frac{kg}{s}$$

$$T_c = 30C$$

$$T_h = 100C$$

$$P = 600kW$$

$$C = 4187\frac{J}{kgK}$$

$$L = 2257000\frac{J}{kg}$$

A)

$$Q = mC(T_h - T_c) + mL$$

$$dQ = C(T_h - T_c)dm + Ldm$$

$$\frac{dQ}{dm} = C(T_h - T_c) + L = 4187\frac{J}{kgK}(100C - 30C) + 2257000\frac{J}{kg} = 2550000\frac{J}{kg}$$

B)

$$P_0 = \frac{dQ}{dt} = (T_h - T_c)\frac{dm}{dt} + L\frac{dm}{dt} = \left(\frac{dm}{dt}\right)[C(T_h - T_c) + L] = \left(\frac{dm}{dt}\right)\left(\frac{dQ}{dm}\right) = 1.5\frac{kg}{s}\cdot 2550000\frac{J}{kg}$$

$$= 3.825\cdot 10^6\frac{J}{s} = 3825\ kW\ .$$

$$e = \frac{P}{P_0} = \frac{600}{3825} = 0.157\ or\ 15.7\%$$