Answer on Question #79807, Physics / Molecular Physics | Thermodynamics

An oil- fired boiler takes in feed water at 75°C and produces wet steam at a pressure of 5 bars. The steam flow rate 1.50 tons/hr with a dryness fraction of 0.89. The fuel consumption rate is 6.10kg/min and its net calorific value is 41MJ/Kg. Determine the thermal efficiency of the boiler.

Solution:

Finding enthalpy of feed water, h_1 and output steam h_2

Use the table http://materias.df.uba.ar/f4aa2015c1/files/2015/03/Tableswater.pdf

$$h_1 = h_f \; at \; 75 \; ℃$$

$$h_1 = 313.93 \; kJ/Kg$$

$$h_2 = h_f + \mathrm{x}h_{fg}$$

$$h_2 = 640 \; kJ/Kg + 0.89 \; x \; 2108 \; kJ/Kg = 2516.12 \; kJ/Kg$$

Finding steam flow rate in kg/s

$$m_s = (1.5 \times 10^3) \; / \; 60^2 = 0.42 \; kg/s$$

Finding power rating of boiler.

$$BPR = (h_2 - h_1) \times m_s$$

$$BPR = (2516.12 \; kJ/Kg \; 2 - 313.93 \; kJ/Kg \;) \; x \; 0.42 \; kg/s = 924.9 \; kJ = 0.925 \; MJ$$

Finding thermal efficiency of boiler

$$\eta = \frac{(h_2 - h_1) \times m_s}{CVm_f}$$

Where m_f = 0.102 kg/s, CV = 41 MJ/Kg

$$\eta = \frac{0.925 \; MJ}{41MJ/Kg \times 0.102 \; kg/s} = 0.22 = 22 \; \%$$

Answer: 22 %