

WASTE HEAT RECOVERY

QUESTION

A reheating furnace has two burners that use furnace oil (FO). Combustion air is supplied directly at ambient temperature of 35⁰C. The company plans to install a recuperator to recover waste heat from the flue gases to preheat the combustion air to 300⁰C.

Calculate the annual furnace oil savings using the following data:

% O ₂ in flue gas:	6 %
Density of furnace oil (FO):	0.9 kg/liter
Annual FO consumption:	750 tons
Specific heat of air(@ 300 ⁰ C):	0.246 kCal/kg ⁰ C
Stoichiometric air to Fuel ratio: (theoretical air requirement)	14 kg air /kg of furnace oil
Furnace efficiency:	20 %
GCV of furnace oil:	10200 kCal/kg
Cost of furnace oil	US\$ 350/ton

SOLUTION

Percentage excess air (EA)

$$\begin{aligned} &= [\% \text{ O}_2 / (21 - \% \text{ O}_2)] \times 100 \\ &= [6 / (21 - 6)] \times 100 \\ &= 40\% \end{aligned}$$

Actual air requirement

$$\begin{aligned} &= (1 + \text{excess air} / 100) \times \text{theoretical air requirement} \\ &= (1 + 0.4) \times 14 \text{ kg air per kg FO} \\ &= 19.6 \text{ kg air / kg FO} \end{aligned}$$

Heat recovery

$$\begin{aligned} &= (\text{Actual air} \times C_p \times \text{Temperature difference}) / \text{Furnace efficiency} \\ &= [19.6 \times 0.246 \times (300-35)] / 0.2 \\ &= 6388.6 \text{ kCal / kg FO} \end{aligned}$$

Annual FO savings

$$\begin{aligned} &= (\text{Heat recovery} \times \text{annual FO consumption}) / \text{GCV of fuel} \\ &= (6388.6 \text{ kCal / kg FO} \times 750,000 \text{ kg FO}) / 10,200 \text{ kCal per kg} \\ &= 469,750 \text{ kg FO/yr} \\ &= 469.75 \text{ tons FO/yr} \end{aligned}$$

Annual monetary savings

$$= 469.75 \text{ kg FO/yr} \times 350 \text{ US\$/ton} = \text{US\$ } 164,412$$