

## BOILERS AND THERMIC FLUID HEATERS

### QUESTION

A company is considering to replace an oil-fired boiler of 10 tons per hour with a coal-fired boiler of the same capacity. With the help of the data provided, calculate the following:

1. Annual oil consumption in tons per year
2. Annual coal consumption in tons per year
3. Annual fuel cost savings in million US\$

The following data is given:

- Heat content of steam 660 kCal/kg
- Feed water inlet temperature 60<sup>0</sup> C
- Daily operating hours 24
- Number of days / year 300
- Efficiency of oil-fired boiler 82%
- Efficiency of coal-fired boiler 72%
- Cost of oil US\$ 300/ton
- Cost of coal US\$ 45/ton
- GCV of oil 10,000 kCal/kg
- GCV of coal 4,200 kCal/kg

## SOLUTION

### 1. Calculate the annual oil consumption in tons per year

Boiler operation per year = 24 hr/day x 300 days/yr = 7200 hrs

Annual steam production =

= steam production rate x annual operation hours

= 10 ton/h x 7,200 hr/yr = 72,000 ton/yr

Energy (Q) required for 72,000 tons steam =

= mass x (hg – hf) ÷ boiler efficiency

= 72,000,000 kg steam/yr x (660 – 60) kCal/kg steam ÷ 0.82

= 52,682,926,830 kCal/yr

Mass of oil (amount of oil required for annual steam production)

=  $Q_{\text{required}} \div \text{GCV}_{\text{oil}}$

= 52,682,926,830 kCal/yr ÷ 10,000 kCal/kg oil

= 5,268,292 kg oil = 5268 tons oil per year

### 2. Calculate the annual coal consumption in tons per year

Boiler operation per year = 24 hr/day x 300 days/yr = 7200 hrs

Annual steam production =

= steam production rate x annual operation hours

= 10,000 kg/hr x 7,200 hr/yr = 72,000,000 kg/yr

Energy (Q) required for 72,000,000 kg steam =

= mass x (hg – hf) ÷ boiler efficiency

= 72,000,000 kg steam/yr x (660 – 60) kCal/kg steam ÷ 0.72

= 60,000,000,000 kCal/yr

Mass of coal (amount of coal required for annual steam production)

=  $Q_{\text{required}} \div \text{GCV}_{\text{coal}}$

= 60,000,000,000 kCal/yr ÷ 4,200 kCal/kg coal

= 14,285,714 kg coal = 14,285 tons coal per year

### 3. Calculate the annual fuel cost savings in million US\$

Cost of fuel oil

= Mass of oil x Cost of oil

= 5,268 ton oil/yr x US\$ 300/ton

= US\$ 1,580,400 per year

Cost of coal

= Mass of coal x Cost of coal

= 14,285 ton oil/yr x US\$ 45/ton

= US\$ 642,825 per year

Fuel saving for coal boiler

= Fuel cost oil boiler – Fuel cost coal boiler

= US\$ 1,580,400 – US\$ 642,825

= US\$ 937,575 per year