

(Solution).

Natural gas

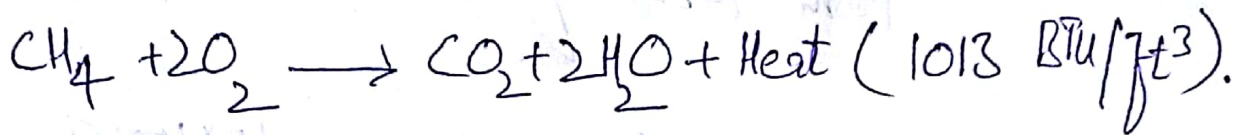
Input 10MM BTU/hr.

output Steam at 55 Psig

Exhaust temperature 450°F

(a) Fuel air ratio

As CH_4 is the Methane.



As

10MM BTU/hr = 10×1000 Per cubic ft

So.

$$\text{fuel-Air ratio} = \frac{1013}{10 \times 10000} = \boxed{0.1013}.$$

(b) "Mass flow rate of fuel and Air."

$$\text{Mass flow rate of fuel} = 0.1013 \times \left[\frac{\text{output Power}}{\text{Input Power}} \right]$$

$$\Rightarrow \dot{m} = 0.1013 \times \left(\frac{\text{at 55 Psig @ 450°F output}}{\text{Input Power.}} \right)$$

$$\Rightarrow \dot{m} = 0.1013 \times \left(\frac{2961.50 \text{ BTU/hr}}{10000 \text{ BTU/hr}} \right)$$

$$\boxed{\dot{m}_{\text{fuel}} = 0.03 \text{ lbm s}^{-1}}$$

$$\dot{m}_{air} = 0.266 \text{ lb-m } \bar{s}^{-1}$$

(c) Feed water at 180°F .

$$\text{Mass flow rate of generator} = \frac{\text{temp. at } 180^\circ\text{F}}{\text{output of feed } H_2O}$$

From tables of steam at 180°F

$$\text{mass flow rate} = \frac{10 \times 10000}{8120}$$

$$\dot{M}_{flow} = 1.231 \text{ lb-m } \bar{s}^{-1}$$

(d) By using the calculator we can expect the Max. flame temperature should be 817°F .

(e) $\eta_{\text{boiler}} \Rightarrow \eta = \frac{\text{temperature produced}}{\text{temperature} + \text{losses}}$

$$\eta \Rightarrow \frac{\text{input energy}}{\text{output energy}}$$

$$\eta = 77.01 \%$$

(f) reduced exhaust 3% then η will
be shoot to the

$$\eta_{\text{revised}} = 77.7 \%$$