$$CH_4 + 2\left(O_2 + 3.77N_2\right) \rightarrow CO_2 + 2H_2O + 7.54N_2$$

$$\frac{N_{air}}{N_{fuel}} = \frac{2 + 2\left(3.77\right)}{1} = 9.54\frac{moles_{air}}{moles_{fuel}} = 9.54\frac{ft^3_{air}}{ft^3_{fuel}}$$

$$\frac{m_{air}}{m_{fuel}} = \frac{9.54\left(29\right)}{1\left(16\right)} = 17.29\frac{lb_{air}}{lb_{fuel}}$$

Calculate the mass of air based on the mass of fuel given, the air-to-fuel ratio, and the amount of excess air.

$$m_{air} = \left(25lb_{fuel}\right)\left(17.29\frac{lb_{air}}{lb_{fuel}}\right)\left(1.3\right) = 562lb_{air}$$

Answer D

47.78 During the process of condensing in a counterflow heat exchanger, the enthalpy of R-410A is reduced from $125\frac{Btu}{lb}$ to $42\frac{Btu}{lb}$. The cooling medium is water which enters at $50°F$ and exits at $75°F$. The surface area of the heat exchanger is $40ft^2$ and the overall coefficient of heat transfer is $10\frac{Btu}{hr\cdot ft^2\cdot °F}$. What is the mass flow rate of refrigerant being condensed?

A. $36\frac{lb}{hr}$

B. $41\frac{lb}{hr}$

C. $46\frac{lb}{hr}$

D. $51\frac{lb}{hr}$

Search for Heat Exchangers and use the formula for the rate of heat transfer in the condenser. Assume $F = 1$. The overall coeffient of heat transfer, U, is given. The area, A, is given.

$$\dot{Q} = UAF\Delta T_{lm}$$

To determine the Log Mean Temperature Difference, ΔT_{lm}, sketch the water cooled condenser and label the entering and exiting refrigerant and water temperatures. Use the Refrigerant 410A table and observe that for the condenser exit condition corresponding to State 3 of the refrigeration cycle, $h_3 = 42\frac{Btu}{lb}$,therefore $P_3 \approx 240psia$ and $T_3 \approx 77°F$. The temperature of the refrigerant throughout the condenser is approximately constant as it is undergoing a phase change at constant pressure.

$$77°F \longleftarrow 77°F$$

$$50°F \longrightarrow 75°F$$

Calculate the temperature differential on each physical side of the exchanger, arbitrarily labeling the sides A & B.

$$\Delta T_A = 77°F - 50°F = 27°F$$

$$\Delta T_B = 77°F - 75°F = 2°F$$

Calculate the Log Mean Temperature Difference, ΔT_{lm}. The formula below is consistent with the formula shown in the reference handbook, but may be easier to correctly apply once the temperature differentials are properly defined. Note that interchanging ΔT_A and ΔT_B leads to the same correct result!

$$\Delta T_{lm} = \frac{\Delta T_A - \Delta T_B}{ln\left(\frac{\Delta T_A}{\Delta T_B}\right)}$$

$$\Delta T_{lm} = \frac{27°F - 2°F}{ln\left(\frac{27°F}{2°F}\right)} = 9.6°F$$

Calculate the heat transfer through the heat exchanger.

$$\dot{Q} = UAF\Delta T_{lm} = \left(10\frac{Btu}{hr \cdot ft^2 \cdot °F}\right)\left(40ft^2\right)(1)(9.6°F) = 3840\frac{Btu}{hr}$$

Equate the heat transfer through the heat exchanger to the quantity of heat given up by the refrigerant, which is a function of the unknown mass flow rate, $\dot{m}_r$, and the change in enthalpy, Δh, of the refrigerant as it flows through the condenser.

$$\dot{Q} = \dot{m}_r(h_2 - h_3)$$

$$\dot{m}_r = \frac{\dot{Q}}{(h_2 - h_3)} = \frac{3840\frac{Btu}{hr}}{\left(125\frac{Btu}{lb} - 42\frac{Btu}{lb}\right)} = 46.3\frac{lb}{hr}$$

Answer C