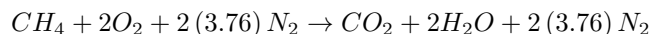


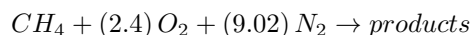
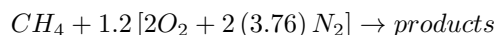
46.16 Methane is burned with 20% excess air. What is the air-to-fuel ratio?

- A. $14 \frac{lb}{lb}$
- B. $17 \frac{lb}{lb}$
- C. $21 \frac{lb}{lb}$
- D. $24 \frac{lb}{lb}$

Look up the table **Combustion Reactions of Common Fuel Constituents** and find the combustion reaction for methane burned stoichiometrically in air. Include 3.76 nitrogen molecules for every 1 oxygen molecule since nitrogen has been omitted in the table. Nitrogen does not participate in the reaction; however, it does contribute mass to the air and thus impacts the air-to-fuel ratio.



Add 20% excess air. Air-to-fuel ratio applies only to the reactants, so it is not necessary to balance the reaction and write out the product side.



Calculate the air-to-fuel ratio by multiplying the number of moles of each constituent times the atomic weight and dividing the air mass by the fuel mass. Use the **Periodic Table** to look up atomic weights as needed.

$$\frac{m_{air}}{m_{fuel}} = \frac{n_{O_2} M_{O_2} + n_{N_2} M_{N_2}}{n_{CH_4} M_{CH_4}} = \frac{(2.4)(32) + (9.02)(28)}{(1)(16)} = 20.6 \frac{lb}{lb}$$

Alternatively, in the **Combustion Reactions** table, notice the heading for **Stoichiometric Oxygen and Air Requirements**. The amount of air required to burn methane stoichiometrically is given as $17.24 \frac{lb}{lb}$. Increase this value by 20% to account for excess air.

$$(1.2) \left(17.24 \frac{lb}{lb} \right) = 20.7 \frac{lb}{lb}$$

Answer C

46.17 A refrigeration cycle using R-134a has a refrigeration effect of $8000 \frac{Btu}{hr}$ and a coefficient of performance of 11. What is the power required to run the compressor?

- A. 210W
- B. 730W
- C. 28KW
- D. 90KW

Use the definition of **Coefficient of Performance for Refrigerators and Air Conditioners**. Solve for the work of the compressor. Convert units to Watts.

$$COP = \frac{Q_L}{W}$$

$$W = \frac{Q_L}{COP} = \frac{8000 \frac{Btu}{hr}}{11} \left(\frac{1W}{3.412 \frac{Btu}{hr}} \right) = 213W$$

Answer A

46.18 100,000 $\frac{lbm}{hr}$ of steam at 5psig with quality $\chi = 0.9$ flows through a pipe with an inside diameter of 20in. What is the velocity?

- A. $230 \frac{ft}{s}$
- B. $255 \frac{ft}{s}$
- C. $850 \frac{ft}{s}$
- D. $940 \frac{ft}{s}$

Since the steam is a saturated mixture, use the quality to determine the specific volume at 5psig. Use the steam table by searching **Properties of Saturated Water and Steam** by pressure. 5psig \approx 20psia. Collect the values for specific volume of a liquid, v_f , and specific volume change during phase change, v_{fg} .

$$v_f = 0.0168 \frac{ft^3}{lb}$$

$$v_{fg} = 20.09 \frac{ft^3}{lb}$$

Use the equation for **specific volume of a two-phase system**.

$$v = v_f + \chi v_{fg} = 0.0168 \frac{ft^3}{lb} + (0.9) \left(20.09 \frac{ft^3}{lb} \right) = 18.1 \frac{ft^3}{lb}$$

Next find the area of a pipe with an inside diameter of 20in in ft^2 .