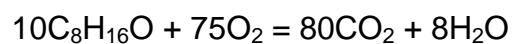


### Question #61159, Chemistry, General Chemistry

3. How many milliliters of air are needed to oxidize 4 lbs of butyl butyrate ( $C_8H_{16}O$ )? Find the number of grams of nitrogen gas present in the air for the combustion. What is the volume reacted (in liters) for nitrogen gas to oxidize butyl butyrate? If the air that will be used for the oxidation of butyl butyrate is a wet air and has 180 grams of moisture ( $H_2O$  vapor), find the volume of the wet air (in liters) at STP.

**Answer:**



a)  $1 \text{ lbs} = 0.454 \text{ kg}$

$$4 \text{ lbs} = 0.454 \cdot 4 = 1.816 \text{ kg} = 1816 \text{ g}$$

According to the reaction, 10 moles of  $C_8H_{16}O$  take 75 moles of  $O_2$ .

$$M(C_8H_{16}O) = 128.215 \text{ g/mol}$$

$$n(C_8H_{16}O) = m/M = 1816/128.215 = 14.164 \text{ moles}$$

$$n(O_2) = 14.164/10 \cdot 75 = 106.227 \text{ moles}$$

$$M(O_2) = 31.998 \text{ g/mol}$$

$$m(O_2) = 106.227 \cdot 31.998 = 3399.077 \text{ g}$$

Oxygen content in the air (by mass) is 23.15%.

$$\text{Therefore, required mass of the air is: } m_{\text{air}} = 3399.077 \cdot 100/23.15 = 14682.841 \text{ g} = 14.683 \text{ kg.}$$

Density of air (at  $20^\circ\text{C}$ ) is  $1.205 \text{ kg/m}^3$ .

$$\text{That is why, required volume of air is } V(\text{air}) = 14.683/1.205 = 12.185 \text{ m}^3 = 12,185,000 \text{ ml}$$

b) Nitrogen content in the air (by volume) is 78.084%.

Therefore, mass of Nitrogen gas in the air required for combustion is:  $14,682.841 \cdot 0.781 = 11,467.299 \text{ g}$ .

c) Nitrogen is not involved to the oxidation process. Its final volume is equal to the initial one.

d) If the air that will be used for the oxidation of butyl butyrate is a wet air and has 180 grams of moisture ( $H_2O$  vapor), the amount of air will be different.

Water content influences air density. Wet air is less dense than dry one at the same temperature.

Water vapor density at STP is  $\rho = 0.804 \text{ kg/m}^3$ .

Initial required mass of air is 14682 g. If 180 g of this mass is substituted by water vapor, then total volume of this mix will be:

$$V_1 = (14.683 - 0.180)/1.205 + 0.180/0.804 = 12.036 + 0.224 = 12.260 \text{ l} = 12,260,000 \text{ ml}$$