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:

$10C_8H_{16}O + 75O_2 = 80CO_2 + 8H_2O$

a) 1 lbs = 0.454 kg

4 lbs = $0.454 \cdot 4 = 1.816$ kg = 1816 g

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

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

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

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

$M(O_2)=31.998$ g/mol

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

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

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

Density of air (at 20°C) is 1.205 kg/m^3.

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

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

Therefore, mass of Nitrogen gas in the air required for combustion is: $14,682.841 \cdot 0.781 = 11,467.299$ 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 airs is less dense then dry one at the same temperature.

Water vapor density at STP is $\rho=0.804$ 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:

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