Answer on Question #64266, Chemistry / General Chemistry

A certain variety of coal is composed of 75% Carbon, 15% Hydrogen and 10% Ash. How many cubic metres of air are required for the complete combustion of 425kg of this fuel

Answer

Carbon and Hydrogen burn, ash remains. Exact formulas of coal's components are not given, so amounts of elements (C and H) will be used in the description of coal composition and in all equations and calculations (do not confuse them with molecules like diatomic gas H_2, which cannot be present in coal).

425kg of the fuel contain:

75% Carbon = 425kg × 0.75 = 318.75 kg of Carbon

15% Hydrogen = 425kg × 0.15 = 63.75 kg of Hydrogen

From the periodic table molar masses of Carbon and Hydrogen:

M(C) = 12.0107 g/mol = 0.0120107 kg/mol

M(H) = 1.00794 g/mol = 0.00100794 kg/mol

Amount of substance: n = m/M

Thus, the amount of each element in coal in moles:

n(C) = m(C) / M(C) = 318.75 kg / 0.0120107 kg/mol = 26538.836 mol

n(H) = m(H) / M(H) = 63.75 kg / 0.00100794 kg/mol = 63247.812 mol

Chemical equations of Carbon and Hydrogen burning are the following:

$C + O_2 \rightarrow CO_2$

$4H + O_2 \rightarrow 2H_2O$

Using stoichiometric ratio it can be determined that 1 mole of O_2 is required for burning 1 mole of C and 1 mole of O_2 is required for burning 4 moles of H. Total amount of oxygen is:

$n(O_2)$ = n(C) + n(H) / 4 = 26538.836 mol + 63247.812 mol / 4 = 42350.789 mol

Molar volume of gas at STP is:

V_m = 22.4 L/mol

So, the volume occupied by required oxygen:

$V(O_2) = n(O_2) \times V_m$ = 42350.789 mol × 22.4 L/mol = 948657.674 L = 948.658 m^3

By volume, dry air contains 20.95% oxygen.

V(air) = $V(O_2)$ / 0.2095 = 948.658 m^3 / 0.2095 = **4528.20 m^3**

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