

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 H₂, which cannot be present in coal).

425kg of the fuel contain:

$$75\% \text{ Carbon} = 425\text{kg} \times 0.75 = 318.75 \text{ kg of Carbon}$$

$$15\% \text{ Hydrogen} = 425\text{kg} \times 0.15 = 63.75 \text{ kg of Hydrogen}$$

From the periodic table molar masses of Carbon and Hydrogen:

$$M(\text{C}) = 12.0107 \text{ g/mol} = 0.0120107 \text{ kg/mol}$$

$$M(\text{H}) = 1.00794 \text{ g/mol} = 0.00100794 \text{ kg/mol}$$

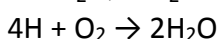
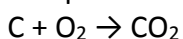
Amount of substance: $n = m/M$

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

$$n(\text{C}) = m(\text{C}) / M(\text{C}) = 318.75 \text{ kg} / 0.0120107 \text{ kg/mol} = 26538.836 \text{ mol}$$

$$n(\text{H}) = m(\text{H}) / M(\text{H}) = 63.75 \text{ kg} / 0.00100794 \text{ kg/mol} = 63247.812 \text{ mol}$$

Chemical equations of Carbon and Hydrogen burning are the following:



Using stoichiometric ratio it can be determined that 1 mole of O₂ is required for burning 1 mole of C and 1 mole of O₂ is required for burning 4 moles of H. Total amount of oxygen is:

$$n(\text{O}_2) = n(\text{C}) + n(\text{H}) / 4 = 26538.836 \text{ mol} + 63247.812 \text{ mol} / 4 = 42350.789 \text{ mol}$$

Molar volume of gas at STP is:

$$V_m = 22.4 \text{ L/mol}$$

So, the volume occupied by required oxygen:

$$V(\text{O}_2) = n(\text{O}_2) \times V_m = 42350.789 \text{ mol} \times 22.4 \text{ L/mol} = 948657.674 \text{ L} = 948.658 \text{ m}^3$$

By volume, dry air contains 20.95% oxygen.

$$V(\text{air}) = V(\text{O}_2) / 0.2095 = 948.658 \text{ m}^3 / 0.2095 = \mathbf{4528.20 \text{ m}^3}$$

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