Pre class activity: Mole balances

Lecture notes for chemical reaction engineering

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Solve the following problems

1. In the Decon process for the manufacture of chlorine, a dry mixture of hydrochloric acid gas and air is passed over a heated catalyst which promotes oxidation of acid. Air is used 30% in excess of that theoretically required. Calculate the weight of air·supplied per kilogram of the acid. (Atomic weight of chlorine = 35.5, Air contains 23.2% O_2 by weight)

2. Chlorobenzene (C_6H_5Cl) is nitrated using a mixture of nitric acid and sulphuric acid. During the pilot plant run, a charge consists of 100 kg of chlorobenzene, 106.5 kg of nitric acid of 65.5% strength, 108 kg of sulphuric acid of 93.6% strength. After two hours of operation, tbc final product mixture was analysed and found to contain 2% unreacted chlorobenzene. Also, the product distribution was found to be 66% paranitrocblorobenzene and 34% orthonitrochlorobenzene (by weight). The chemical reaction involved are:

$$C_6H_5Cl + HNO_3 \rightarrow oC_6H_4ClNO_2 + H_2O$$
$$C_6H_5Cl + HNO_3 \rightarrow pC_6H_4ClNO_2 + H_2O$$

   Calculate:

   (a) analysis of charge,
   (b) % conversion of chlorobenzene and
   (c) composition of the product mixture. (Atomic weight data: H = 1, N = 14, S = 32, Cl = 35.5)

3. Pure sulphur is burnt in a sulphur burner with dry air. Oxygen is used 20% excess above that required for the complete combustion of sulphur lo SO_3 The efficiency of burner is such that only 30% of the sulphur burns to SO_3 and remainder goes to SO_3.

   Calculate:

   (a) the analysis of the resulting mixture in mole% and
   (b) the weight of gas per kg of sulphur burnt.