淡江大學 99 學年度轉學生招生考試試題
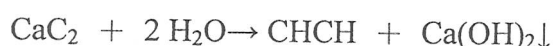
系別：化學工程與材料工程學系三年級　科目：質　能　均　衡

1. For the making of 6000 ft^3 of acetylene (CHCH) gas at 70°F and 750 mm Hg, solid calcium carbide (CaC$_2$) which contains 97 wt % CaC$_2$ and 3 wt % solid inerts is used along with water. The reaction is

$$CaC_2 + 2 H_2O \rightarrow CHCH + Ca(OH)_2 \downarrow$$

The final lime slurry contains water, solid inerts, and Ca(OH)$_2$ lime. In this slurry the total wt % solids of inerts plus Ca(OH)$_2$ is 20 %. How many lb of water must be added and how many lb of final lime slurry is produced？ Atomic weight of Ca is 40. (25%)

2. Formaldehyde (CH$_2$O) is made by the catalytic oxidation of pure methanol vapor and air in a reactor. The moles from this reactor are 63.1 N$_2$, 13.4 O$_2$, 5.9 H$_2$O, 4.1 CH$_2$O, 12.3 CH$_3$OH and 1.2 HCOOH. The reaction is

$$CH_3OH + \frac{1}{2} O_2 \rightarrow CH_2O + H_2O$$
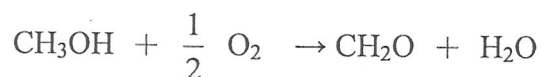
A side reaction occurring is

$$CH_2O + \frac{1}{2} O_2 \rightarrow HCOOH$$
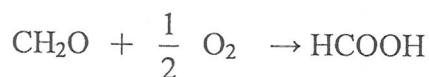
Calculate the mol methanol feed, mol air feed, and percent conversion of methanol to formaldehyde. (25%)

3. It is desired to produce 1000 kg/h of Na$_3$PO$_4 \cdot$ 12H$_2$O crystals from a feed solution containing 5.6 wt% Na$_3$PO$_4$ and traces of impurity. The original solution is first evaporated in an evaporator to a 35 wt% Na$_3$PO$_4$ solution and then cooled to 293 K in a crystallizer, where the hydrated crystals and a mother liquor solution are removed. One out of every 10 kg of mother liquor is discarded to waste to get rid of the impurities, and the remaining mother liquor is recycled to the evaporator. The solubility of Na$_3$PO$_4$ at 293 K is 9.91 wt%. Calculate the kg/h of feed solution and kg/h of water evaporated. (25%)

4. The waste gas from a process of 1000 g mol/h of CO at 573 K is burned at 1 atm pressure in a furnace using air at 473 K. The combustion is complete and 50% excess air is used. The flue gas leaves the furnace at 1273 K. Calculate the heat removed in the furnace.

$$CO + \frac{1}{2} O_2 \rightarrow CO_2 \qquad \Delta H_{298}^O = -282.989 \times 10^3 \text{ kJ/kg mol}$$

Mean molar heat capacities of CO, O$_2$, CO$_2$, N$_2$ and Air are 29.60, 33.25, 49.91, 31.43 and 29.40 kJ/kg mol $\cdot$ K, respectively. (25%)