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Process engineering department
3rd year L.M.D – Homogeneous reactor
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Homogeneous reactor
Series N° 01

Exercise 1:

The following reactions represent the reforming of methane with steam (la vapeur d'eau)

$$CH_4 + H_2O \rightarrow 3H_2 + CO$$

$$CO + H_2O \rightarrow CO_2 + H_2$$

$$CH_4 + 2H_2O \rightarrow 4H_2 + CO_2$$

- What will be the notation of the stoichiometric coefficient of CO_2 in reaction number 2?
- What does the stoichiometric coefficient $\nu_{3.3}$ correspond to? What is its value?
- Calculate the stoichiometric expansion of the 3rd reaction.

Exercise 2:

The following reactions are carried out in an open reactor with a steady state. This reactor is powered continuously by: 15 mol/h of methane, 35 mol/h of dioxygene and 5 mol/h of water.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

- What is the limiting reagent of this reaction? Explain with and without calculation.
- For a conversion rate of 80% of the limiting reagent, calculate the molar flows that leaving the reactor

Exercise 3:

In an open reactor operating on a steady state, 0.310 mol/s of methane and 0.26 mol/s of air are injected (in presence of 0.98 mol/s of Azote that consider as inert).

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

$$CH_4 + H_2O \rightarrow CO + 3H_2$$

$$CH_4 + CO_2 \rightarrow 2CO + 2H_2$$

- Determine the normalized advancement of the three reactions knowing that the flow leaving the reactor contains : 2,9% of methane, 1,8% of oxygen, 53,4% of nitrogen, 1,6% of carbon dioxide, 9,3% of water, 18,6% of hydrogen and 12,4% of carbon monoxide.

Exercise 4:

Inside a closed reactor; 0,25 mole of ethanol and 1 mole of O_2 are added. The combustion of ethanol is represented by the following reaction: $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

- Give the stoichiometric notation of each element.
- Indicate the limiting reagent.
- Knowing that: $\Sigma\ \nu i\ Ai = 0$, give the sentences indicates the proportion between the number of moles and the stoichiometric coefficient.

- What is the number of moles of CO_2 formed and O_2 left when burning totally alcohol?
- Calculate the chemical advancement of the reaction and give a conclusion.

Exercise 5:

By the action of hydrochloric acid (HCl), it is possible to remove rust (Fe_2O_3) forming on the sheets.

The reaction being: $Fe_2O_3 + 6HCl \rightarrow 2FeCl_3 + 3H_2O$

- How much rust can be removed with a solution containing 3.60 g of HCl?

Exercise 6:

The combustion equation for ethanol is : $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

3 moles of ethanol and 5 moles of dioxygen are reacted together; one of the reagents disappears completely.

- How many moles of carbon dioxide, CO_2, are formed at the end of the reaction?

Exercise 7:

We consider the combustion of acetone: $C_3H_6O + 4O_2 \rightarrow 3CO_2 + 3H_2O$

We burn 2 moles of acetone in 4 moles of oxygen. One of the reagents disappears completely.

- Give the composition in moles of the reaction medium at the end of the reaction.

Exercise 8:

We consider the reaction equation for the preparation of chlorine from manganese dioxide and hydrogen chloride:

$MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$.

3 moles of manganese dioxide are reacted with 5 moles of hydrogen chloride. One of the reagents disappears.

- Give the composition in moles of the reaction medium at the end of the reaction.

Exercise 9:

The ammonia synthesis reaction equation being: $N_2 + 3H_2 \rightarrow 2NH_3$

- Give the stoichiometric notation of this reaction.
- What is the number of moles of ammonia obtained and hydrogen disappeared when 0.127 moles of dinitrogen reacted with the strictly necessary quantity of dihydrogen?
- Calculate the chemical progress of the reaction in relation to the three constituents. Conclude.