

CHG 1125

QUIZ 4

Last Name: _____

First Name: _____

Student Number: _____

Duration: 30 minutes

The following labeled flowchart describes a reactive process that shows the production of formaldehyde (HCHO) from methane (CH₄) oxidation.

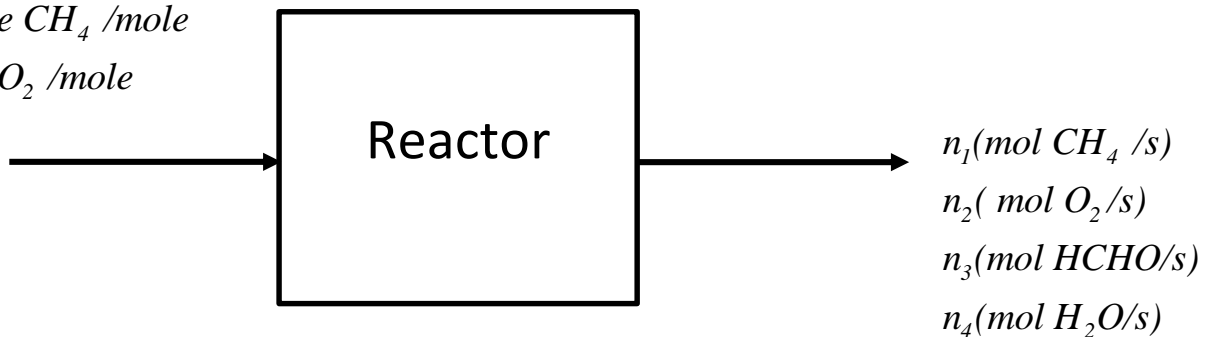


The feed to the reactor has a flow rate of 100 mole/s with molar composition of methane of 40% and the balance is oxygen. The conversion of CH₄ is 80%. Calculate the composition of the exit stream.

100 mole/s

0.4 mole CH₄ /mole

0.6 mol O₂ /mole



Solution:

There are 5 unknowns (n_1, n_2, n_3, n_4, ξ)

Where ξ =moles CH_4/s that have reacted in the first reaction

We can write 4-balance equations on each component (4 equations), to get the other equation to solve the system, the conversion of methane is given as 80% and this information can be used as an extra relation and the degree of freedom of the system will be zero.

80% conversion :

$$\frac{40 - n_1}{40} = 0.8 \quad \textcircled{R} \quad n_1 = 8 \frac{\text{molCH}_4}{\text{s}} \quad (1)$$

Performing mass balance on each component

$$\begin{aligned} \text{CH}_4 : n_1 &= 40 - x = 8 \quad \textcircled{R} \\ x &= 40 - 8 = 32 \text{ moles reacted} \end{aligned} \quad (2)$$

$$\text{O}_2 : n_2 = 60 - x = 60 - 32 = 28 \text{ moles O}_2 / \text{s} \quad (3)$$

$$\text{HCHO} : n_3 = 0 + x = 32 \text{ molHCHO/s} \quad (4)$$

$$\text{H}_2\text{O} : n_4 = 0 + x = 32 \text{ moles H}_2\text{O/s} \quad (5)$$

Therefore the total molar flow rate at the outlet of the reactor, is the summation of the all the molar flow rates calculated above

$$\begin{aligned} \sum_{i=1}^5 n_i &= 8 + 28 + 32 + 32 = 100 \text{ moles} \quad \textcircled{R} \\ y_{\text{CH}_4} &= 0.08, \quad y_{\text{O}_2} = 0.28, \quad y_{\text{HCHO}} = 0.32, \quad y_{\text{H}_2\text{O}} = 0.32 \end{aligned}$$