Production of Methanol from CO_2

Submitted By: Priyanshu Maurya

Roll No.: 220827

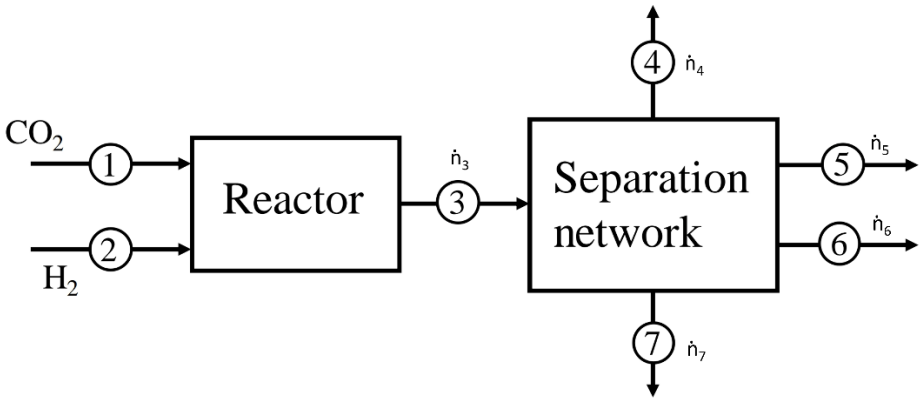
TA: Praful Mane

AIM

The goal of the laboratory session is to determine molar flow rate of CO_2, H_2, CH_3OH and H_2O.

METHOD

Approach 1: We first assign variables to different molar rates at each process as shown below,



Approach 2: To find degree of freedom:

Number of variables = 4

Number of mass balance equations = 4

Therefore, degree of freedom = (Number of variables) – (Number of mass balance equations)

= 4-4

= 0

Approach 3: Using appropriate mass and energy balances, we can form equations as follows:

$n_7 = 893.263$ kmol/hr

$0.176(n_3) - 0.243(n_4) - 0.744(n_5) = 0.002(n_7)$

$0.53(n_3) - 0.752(n_4) - 0.027(n_5) = 0$

$0.147(n_3) - 0.004(n_4) - 0.188(n_5) = 0.987(n_7)$

$$0.147(n_3) - 0.001(n_4) - 0.041(n_5) - n_6 = 0.011(n_7)$$

Approach 4: We have the following matrix equation. Using MATLAB function linsolve, we will solve for n_3, n_4, n_5, & n_6

$$\begin{bmatrix} 0.176 & -0.243 & -0.744 & 0 \\ 0.530 & -0.752 & -0.027 & 0 \\ 0.147 & -0.004 & -0.188 & 0 \\ 0.147 & -0.001 & -0.041 & -1 \end{bmatrix} \begin{bmatrix} \mathbf{n_3} \\ \mathbf{n_4} \\ \mathbf{n_5} \\ \mathbf{n_6} \end{bmatrix} = \begin{bmatrix} 0.002(\mathbf{n_7}) \\ 0 \\ 0.987(\mathbf{n_7}) \\ 0.011(\mathbf{n_7}) \end{bmatrix}$$

RESULTS and ANALYSIS

After solving using linsolve in MATLAB we get :

n_3 = 6163.5 kmol/hr

n_4 = 4342.6 kmol/hr

n_5 = 37.3 kmol/hr

n_6 = 890.3 kmol/hr

Using Gauss Elimination, we get the following triangular matrix :

$$\begin{bmatrix} 0.176 & -0.243 & -0.744 & 0 \\ 0 & -0.0202 & 2.2135 & 0 \\ 0 & 0 & 22.1932 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} n3 \\ n4 \\ n5 \\ n6 \end{bmatrix} = \begin{bmatrix} 1.7865 \\ 5.3799 \\ 936.0308 \\ -891.0654 \end{bmatrix}$$

Solving for different variables:

-1* n_6 = -891.0654

22.1932* n_5 = 936.0308

-0.0202* n_4 + 2.2135* n_5 = 5.3799

0.176* n_3 - 0.243* n_4 - 0.744* n_5 = 1.7865

CONCLUSION

We got the molar flow rate for all the processes. And we also verified the value obtained from linsolve, using Gauss Elimination.

APPENDIX

The MATLAB code to solve the problem is as follows:

```
m7= 893.263;
A=[0.176 -0.243 -0.744 0;
   0.53 -0.752 -0.027 0;
   0.147 -0.004 -0.188 0;
   0.147 -0.001 -0.041 -1];`
b = [0.002*m7;
     0;
     0.987*m7;
     0.011*m7];

% using linsolve function to solve matrix equation
x= double(linsolve(A, b));
```