

### Example 4 (Reactive system)

Consider the following flow sheet:

The reaction:  $\text{HI} + \text{CH}_3\text{OH} \rightleftharpoons \text{CH}_3\text{I} + \text{H}_2\text{O}$  Let (A=HI; M=CH<sub>3</sub>OH; B=CH<sub>3</sub>I and W=H<sub>2</sub>O).

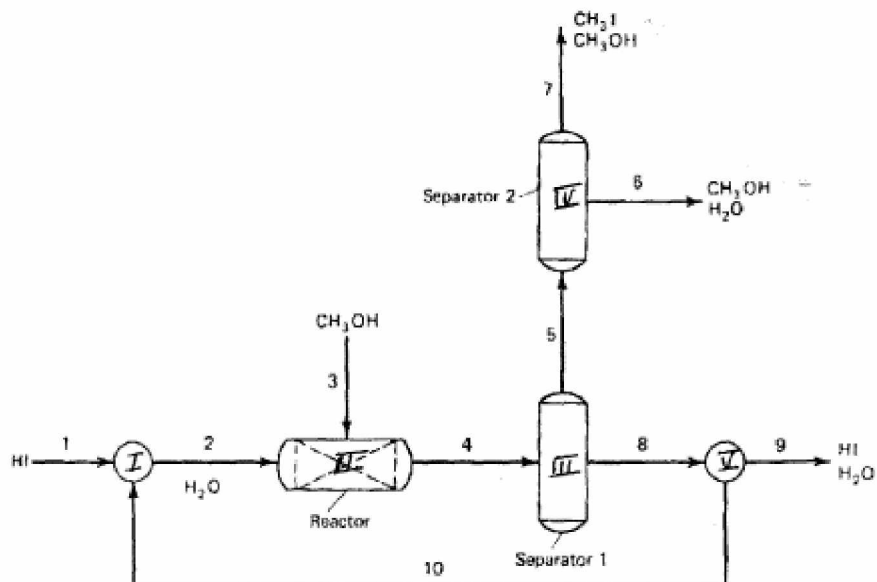
(a) Unit V is a splitter

(b)  $y_{10}^W = 0.1$  ;  $y_7^B = 0.75$  ;  $y_6^M = 780/860$  ;  $\frac{n_3^M}{n_2^A} = 2$  ;  $\frac{n_5^W}{n_4^W} = 2/3$

(c) The conversion of A (HI) in the reactor is 20%

**Calculate:**

- 1- moles of CH<sub>3</sub>I produced per moles of HI fed
- 2- Overall conversion of HI



## Degree of Freedom Table

	Unit I	Unit II	Unit III	Unit IV	Unit V	Overall	Process
<b>Streams</b>	1,2,10	2,3,4	4,5,8	5,6,7	8,9,10	1,3,6,7,9	1-10
Unknowns	5	7	9	7	6	8	21
Reactions	0	1	0	0	0	1	1
Total U	<b>5</b>	<b>8</b>	<b>9</b>	<b>7</b>	<b>6</b>	<b>9</b>	<b>22</b>
M.B.Equs	2	4	4	3	2	4	15
Flows	0	0	0	0	0	0	0
Composition	1	0	0	2	1	2	3
Relations	0	2	1	0	0+1	0	3+1
Total I	<b>3</b>	<b>6</b>	<b>5</b>	<b>5</b>	<b>4</b>	<b>6</b>	<b>22</b>
I-U	<b>-2</b>	<b>-2</b>	<b>-4</b>	<b>-2</b>	<b>-2</b>	<b>-3</b>	<b>0</b>
Basis							MUST
							<b>Solvable</b>

The degree of freedom table indicates that the process is solvable. However, Since no flow is specified, one has to start the solution by assuming a flow rate (otherwise can't solve).

### EZSOLVE PROGRAM

// MATERIAL BALNCES (=15)

**//UNIT 1**

$$A1+A10=A2$$

$$W10=W2$$

**//UNIT 2**

$$A2-R=A4$$

$$M3-R=M4$$

$$W2+R=W4$$

$$B4=R$$

**//UNIT 3**

$$A4=A8$$

$$M4=M5$$

$$B4=B5$$

$$W4=W5+W8$$

**//UNIT 4**

$$B5=B7$$

$$M5=M7+M6$$

$$W5=W6$$

**//UNIT 5 SPLITTER**

$$A8=A9+A10$$

$$W8=W9+W10$$

**// FLOW RATES (=0); then, BASIS**

$$A1=100$$

**// COMPOSITIONS (=3)**

$$W6=80/780*M6$$

$$B7=75/25*M7$$

$$W10=10/90*A10$$

**// RELATIONS (=4)**

$M3/A2=2$

$(A2-A4)/A2=0.2$

$W5/W4=2/3$

$A10/(A10+W10)=A9/(A9+W9)$  //splitter

//

$CH_3I \text{ Production} = B7/A1$

$OC = (A1-A9)/A1*100$

**Results**

<b>A1</b>	<b>A2</b>	<b>A4</b>	<b>A8</b>	<b>A9</b>	<b>A10</b>	
100.00	250.00	200.00	200.00	50.00	150.00	
<b>M3</b>	<b>M4</b>	<b>M5</b>	<b>M6</b>	<b>M7</b>		
500.00	450.00	450.00	433.33	16.67		
<b>B4</b>	<b>B5</b>	<b>B7</b>				
50.00	50.00	50.00				
<b>W2</b>	<b>W4</b>	<b>W5</b>	<b>W6</b>	<b>W8</b>	<b>W9</b>	<b>W10</b>
16.67	66.67	44.44	44.44	22.22	5.56	16.67
<b>OC</b>		<b>Production</b>		<b>R</b>		
<b>50.00</b>		<b>0.50</b>		<b>50.00</b>		

Overall conversion = 50%

$CH_3I/HI = 50/100 = 0.5$